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SVIC NOTES

MICROCOMPUTERS IN SHOCK AND VIBRATION

I do not know whether the developers of microcomputers ever foresaw their use for scientific or engineering calculations, but according to several articles in the recently published literature they are being used to perform many types of shock and vibration calculations, and they are being used to do this to an ever increasing extent. The microcomputer was deliberately designed to be easy to use from the outset, and this design philosophy is largely responsible for their increasing popularity; this same design philosophy appears to have been carried over to the design of today's more powerful models.

The use of microcomputers in shock and vibration is not new; they have been used in experimental applications almost since their inception. Some of the tasks included shock spectra computations, balancing of rotating shafts, acquisition and processing of materials properties data and spectral analysis. The computing power of the early models of microcomputers was limited, but the rapid advances in the digital electronics technology have resulted in the availability of more powerful computers that are both inexpensive and easy to use. The newer models of microcomputers are capable of performing far more extensive experimentally oriented computation tasks such as processing measured field data, machinery condition monitoring, machinery diagnosis and structural modification analysis, ~~to name~~ a few.

The increased power of the microcomputer is also significantly impacting shock and vibration analyses. Many problems that may have been previously run on mainframe computers, or minicomputers, are now small enough so they may be run on microcomputers with little, if any, loss in accuracy. Exploratory dynamic analyses of complex systems are often necessary, and this is another type of problem that might be run on a microcomputer. This type of analyses is undertaken to understand the dynamic behavior of the system, and because of the exploratory nature of this type of study, the analysis can often be simplified so that the problem is small enough to be run on a microcomputer.

The advent of the more powerful microcomputer has also led to the development of many software packages for engineering computations which were specifically written for use on microcomputers. Software packages related to shock and vibration are available for both experimental and for analytical applications. Typical software packages for experimental applications include Fourier analysis, structural modification analysis and machinery condition monitoring. The analytically oriented software ranges from specialized problem solving algorithms to finite element codes for structural dynamics. Further, many of the finite element codes incorporate a graphics capability which allows the analyst to interact with the computer in generating a mathematical model, or to visualize the results of an analysis. But, a very important feature of most of these software packages is they were purposely written so they would be easy to use; I believe the availability of easy to use software is not only another advantage of the microcomputer, it is another good reason for its increasing popularity.

Microcomputers do have some performance limitations, and the ones most often cited in the literature refer to their memory capacity, their processing speed and their lack of multiple task processing capability. However, the state of the digital electronics technology continues to advance rapidly, and this should improve the performance of microcomputers in the future. But, when the presently available microcomputers are used within their limits, they are an effective tool for solving many shock and vibration problems.

R.H.V.

EDITORS RATTLE SPACE

SOME THOUGHTS ON VIBRATION TEXTBOOKS

Since Dr. Neville Rieger published his article "The Literature of Vibration Engineering" in the Digest in January of 1982, the flow of new books on mechanical vibrations has increased. The new books reflect computational, testing, and design techniques such as finite element modeling, modal testing, and isolation system design; descriptions of such phenomena as damping; and fundamental tutorial material. While many of these textbooks bring new technology from the literature in an organized and distilled form, many continue to rehash previously published material.

In my opinion, the purpose of a book is to present new technology in a readable and useable format. I believe the fundamental concepts such as the single-degree-of-freedom system have been adequately described in hundreds of texts. It is amazing to me that authors continue to repeat such material in new books without variation or enhancement. In fact, many times the new versions are more obtuse than previously published classical works. The sad part of the story is that some good, basic, tutorial books have been allowed to go out of print -- either from lack of use or date of publication. A new textbook should bring the new technology scattered in the literature to a single organized source. While we are seeing more and more of this type book, there is room for many more on the market.

Since it is a monumental task to write any textbook, and authors are rarely properly compensated, why not make the contribution worthwhile.

R.L.E.

A REVIEW OF THE LITERATURE ON FINITE-ELEMENT MODELING OF LAMINATED COMPOSITE PLATES

J.N. Reddy*

Abstract. This review of the literature on the finite-element modeling of natural vibrations of plates is confined to the period from 1980 to the present. A historical background of the development of shear deformation theories is also presented.

Composite materials are now being used in many structures; applications range from medical prosthetic devices, sports equipment, electronics, appliances, and automotive parts to high-performance aircraft structures. The strength and lightweight requirements of structures for space also created considerable interest in the study of composite plates.

Previous analyses of laminated composite plates were based on either three-dimensional elasticity theory or lamination theories. Three-dimensional elasticity theory treats each layer as an elastic continuum with possibly distinct material properties from adjacent layers. The number of governing differential equations is thus 3N; N is the number of layers in the laminate. Continuity of displacements and stresses at the interface of two layers creates additional relationships. The equations become intractable as the number of layers becomes large.

In lamination theories it is assumed that the laminate is in a state of plane stress, the individual laminae are elastic, and there is perfect bonding between layers. Laminate properties (i.e., stiffnesses) are obtained by integrating lamina properties through the thickness. Lamination theories are thus equivalent single-layer theories. The classical lamination theory (CLT), which is an extension of the classical plate theory (CPT) to laminated plates, ignores the transverse stress components; a laminate is modeled as an equivalent single layer. The first complete lamination plate theory was that of Yang, Norris and Stavsky [1]. The classical lamination theory is adequate for many engineering problems.

However, laminated plates made of such advanced filamentary composite materials as graphite-epoxy -- with very large elastic to shear modulus ratios -- are susceptible to thickness effects because their effective transverse shear moduli are significantly smaller than the effective elastic moduli along fiber directions. These high ratios of elastic to shear modulus render the classical lamination theory inadequate for the analysis of composite plates. An adequate theory must account for accurate *distribution of transverse shear stresses.*

The first stress-based shear deformation plate theory was that of Reissner [2-4]. The theory is based on a linear distribution of the in-plane normal and shear stresses through the thickness,

(2)

$$\sigma_1 = \frac{M_1}{(h^2/6)}\frac{z}{(h/2)},\ \sigma_2 = \frac{M_2}{(h^2/6)}\frac{z}{(h/2)},\ \sigma_6 = \frac{M_6}{(h^2/6)}\frac{z}{(h/2)}$$

where (σ_1, σ_2) and σ_6 are the normal and shear stresses, (M_1, M_2) and $M6$ are the associated bending moments (which are functions of the in-plane coordinates x and y), z is the thickness coordinate, and h is the total thickness of the plate. The distribution of the transverse normal and shear stresses (σ_3, σ_4, and σ_5) is determined from the equilibrium equations of the three-dimensional elasticity theory. The differential equations and the boundary conditions of the theory were obtained using Castigliano's theorem of least work.

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The origin of displacement-based theories is apparently attributed to Basset [5], who began his analysis with the assumption that the displacement components in a shell can be expanded in a series of powers of the thickness coordinate ζ. For example, the displacement component u_1 is written in the form

$$\text{(2a)} \quad u_1(\xi_1,\xi_2,\zeta) = u_1^0(\xi_1,\xi_2) + \sum \zeta^n u_1^{(n)}(\xi_1,\xi_2)$$

where ξ_1 and ξ_2 are the curvilinear coordinates in the middle surface of the shell; $u_1^{(n)}$ have the meaning

$$\text{(2b)} \quad u_1^{(n)}(\xi_1,\xi_2) = \frac{d^n u_1}{d\zeta^n}\Big|_{\zeta=0} \quad , \quad n = 0,1,2,\ldots$$

Basset's work did not receive as much attention as it deserves. Others [6, 7] presented a displacement-based shear deformation theory for shells that can be specialized to flat plates. The following displacement field was assumed.

$$\text{(3)} \quad \begin{aligned} u_1(\xi_1,\xi_2,\zeta) &= u(\xi_1,\xi_2) + \zeta\ \psi_x(\xi_1,\xi_2) \\ u_2(\xi_1,\xi_2,\zeta) &= v(\xi_1,\xi_2) + \zeta\ \psi_y(\xi_1,\xi_2) \\ u_3(\xi_1,\xi_2,\zeta) &= w(\xi_1,\xi_2) \end{aligned}$$

The differential equations of the theory are derived using the principle of minimum total potential energy. The result is five differential equations in the five displacement functions, u, v, w, ψ_x, and ψ_y.

The shear deformation theory based on the displacement field in equation (3) for plates is often referred to as the Mindlin's plate theory. Mindlin [8] presented a complete theory based on the displacement field (3) taken from Hencky [7]. The literature review points out that the basic idea came from Basset [5]; Hildebrand, Reissner, and Thomas [6]; and Hencky [7]. Therefore, by referring to the displacement-based shear deformation theory as Mindlin's theory we are not giving due credit to the others. We shall refer to the shear deformation theory based on the displacement field (3) as the first-order shear deformation theory.

Higher-order, displacement-based, shear deformation theories have been investigated by Nelson and Lorch [9]; Librescu [10]; and Lo, Christensen, and Wu [11]. These higher-order theories are cumbersome and computationally demanding because, with each additional power of the thickness coordinate, an additional dependent unknown is introduced, per displacement component, into the theory. Levinson [12] and Murthy [13] presented third-order theories that assume transverse inextensibility. The nine displacement functions were reduced to five by requiring that the transverse shear stresses vanish on the bounding planes of the plate. However, both authors used the equilibrium equations of the first-order theory in their analysis. In other words, the higher-order terms of the displacement field are accounted for in the calculation of the strains but not in the governing differential equations or in the boundary conditions. Reddy [14, 15] recently corrected these theories by deriving the governing differential equations from variational principles.

A generalization of the first-order shear deformation plate theory for homogeneous isotropic plates to arbitrarily laminated anisotropic plates has been made [16, 17]. These refined plate theories provide improved global response estimates for deflections, vibration frequencies, and buckling loads for laminated composites. However, through-the-thickness stress response in localized regions of geometric, load, and material discontinuities require more detailed analysis. For example, interlaminar stresses, which are significant close to the straight free edge of tensile coupons, cutouts, and supported edges are neglected in the formulation of single-layer theories. To account for three-dimensional effects a ply-by-ply, three-dimensional analysis is required. Such theories have been developed [18-22].

Although the three-dimensional theories give more accurate results than the lamination (classical or shear deformation) theories, they are intractable. For example, the local theory of Pagano [23] results in a mathematical model consisting of 23N partial differential equations in the midplane coordinates of the laminate and

7N edge boundary conditions; N is the number of layers in the laminate. The storage and computational costs, especially for geometrically nonlinear problems or transient analysis using the finite element method, preclude the use of such a theory. Because the refined shear deformation theory gives as accurate a global response as the three-dimensional theory but is computationally less demanding, it is considered efficient for problems not involving regions of acute discontinuities.

The *conventional variational* formulation of the classical lamination theory [17] as well as the third-order theory [15] involves higher order (i.e., second-order) derivatives of the transverse displacement. Therefore, in the finite-element modeling of such theories the continuity of not only the transverse displacement should be imposed but also its derivatives along the element boundary. In other words, a conforming plate bending element based on a displacement formulation of these theories requires the continuity of transverse displacements and their derivatives across the inter-element boundaries. The construction of such an element is algebraically complicated, requiring, for example, a quintic polynomial with 21 degrees of freedom for a six-node triangular element.

To overcome the stringent continuity requirements of the conventional variational formulation, several alternative formulations and associated elements have been developed. These include hybrid finite elements, mixed finite elements, and shear flexible elements based on the first-order shear deformation theory. Hybrid elements are based on variational statements that use independent variation of displacements inside the domain of the element and tractions on the boundary of the element [24-26]. Mixed elements use stationary variational principles, such as the Reissner variational principle or the Hu-Washizu variational principle, to construct independent variations of both displacements and bending moments in a plate [27-33]. The shear flexible element -- often called the Mindlin element in finite element circles -- is based on the total potential energy formulation of the first-order shear deformation theory of plates [34-44]. Exact solutions and conventional and mixed finite-element models of a higher-order theory [15] have been reported [45-48]. Natural vibration of laminated plates using three-dimensional elasticity theory has also been studied [49].

A review of the literature reveals that the number of papers published in the last four years on the finite-element modeling of laminated plates is small compared to the total number of papers published on the vibration of plates. Most of the papers are concerned with the development of new theories and/or new finite element models in an effort to include the transverse shear deformation effects [50]. A review of literature prior to 1981 on this topic is available [51].

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four reviews each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the **DIGEST** reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

MECHANICAL FACE SEAL DYNAMICS UPDATE

L. Etsion*

Abstract. This review is an update of literature published since 1981 on mechanical face seal dynamics. Experimental observations as well as theoretical analyses are summarized. Future research needs in mechanical face seal dynamics are pointed out.

A review of the literature on mechanical face seal dynamics through 1981 has been presented [1]. Work up to that time can be divided into three main areas: experimental observation of seal vibration; dynamic properties of seal elements including experimentation with the flexible support of the seal and theoretical work on dynamic properties of the fluid film; and theoretical analyses of mechanical seal dynamics.

Work since 1981 on mechanical face seal dynamics can be divided into these same general areas. Earlier theoretical work on properties of the fluid film provided only indirect information about stiffness and damping. Theoretical analyses of mechanical seal dynamics that were in a preliminary stage up to 1981 are now a useful tool for predicting the dynamic behavior of a realistic seal. Until 1981 experimental work with mechanical seals was mainly limited to qualitative observations of seal vibrations. Recent experimental work has been aimed mainly at quantitative studies of the dynamic behavior of mechanical seals; some attempts have been made to correlate experimental and theoretical results. The present update is divided into the three areas mentioned above.

DYNAMIC PROPERTIES OF SEAL ELEMENTS

Fluid film. Stiffness and damping coefficients of the fluid film in coned and flat face seals have been analyzed [2]. The analysis is based on a small perturbation and provides closed form analytical expressions for the dynamic properties. The results were shown to be valid beyond the range of a small perturbation and hence are useful for any practical application.

Squeeze effects in coned face seals have been analyzed [3], as has stiffness in the presence of cavitation [4, 5]. Stiffness and damping coefficients of a fluid film in a shrouded pocket type seal are available [6].

The relationship of axial lift force and film thickness has been predicted for a self-acting spiral-groove gas seal [7, 8]. Effects of phase change (boiling sealed liquid in the sealing dam) on load support as a function of film thickness in mechanical seals have been studied [9] for both flat and coned face seals. Results showed that the load support generated by the fluid pressure can have many values for a given film thickness and that axial stiffness can be either positive or negative, depending on the seal clearance. The effect of waviness of the mating faces in mechanical face seals has also been analyzed [10].

Flexible support. The stiffness and damping characteristics of elastomer O-rings subjected to reciprocating twist of their cross section has been studied experimentally [11]. Such reciprocating twist is similar to the mode of operation of elastomeric secondary seals in mechanical face seals when the flexibly mounted element of the seal tracks axial runout of the rigidly mounted element. For the stiffness coefficient exponential functions were found in the form

$$K = A\omega^B$$

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The damping coefficient was

$$D = a\omega^b$$

In these equations ω is shaft speed; A, B, a, and b are constants related to elastomer material and geometry. It was also found that in general the stiffness provided by a secondary seal O-ring can be much higher than that of the mechanical springs found in the flexible support of mechanical seals. Axial force/displacement characteristics of elastomer seals in water have been presented [12].

The kinematic constraint imposed on a flexibly mounted element either by antirotation locks -- when the element is the stator -- or by positive drive devices -- when it is the rotor -- has been studied [13]. The equation of kinematic constraint was derived and presented in a simple general form for all possible types of antirotation or positive drive mechanisms found in practical applications.

THEORETICAL ANALYSES OF MECHANICAL SEAL DYNAMICS

A small-perturbation dynamic analysis of a noncontacting coned face seal has been presented [14]. The dynamic properties of both the fluid film and the flexible support, including the elastomeric secondary seal, are accounted for, as are axial runout of the rotor and initial assembly misalignment. An expression was provided for a critical speed above which the seal becomes dynamically unstable and for a critical rotor runout above which the seal will fail, in its stable mode of operation, due to face contact.

In later work [15] the restriction of a small perturbation was removed; total nonlinear effects on seal dynamics were considered. A transient solution was performed numerically; the critical speed for stability threshold and the critical rotor runout that causes local face contact were found. A comparison between the more accurate numerical results and those based on the small perturbation analysis showed the validity of the latter in most practical applications.

Other papers [8, 9] also deal with dynamic analyses of mechanical seals. A specific design of a spiral-groove face seal for liquid oxygen was analyzed and its dynamic behavior discussed [8]. A quasi-steady transient analysis was made for axial excursions of a seal ring in the case of phase change taking place in the sealing dam [9].

EXPERIMENTAL OBSERVATION OF SEAL DYNAMICS

Experimental observations of seal dynamics until 1981 were mostly qualitative and showed that the seal is indeed a dynamic system. Since 1981 experimental work has become more quantitative in that measurements of film thickness and motions of seal components have been made. Test rigs used for high-pressure water seals in nuclear applications have been described [16]. Proximity probes were used to monitor rotor misalignment and to measure response of the flexibly mounted stator. Although the tests were designed for water seals, they can be adapted to other mechanical seal applications.

Qualitative results of tests of noncontacting seals for liquid oxygen have been reported [17]; the mechanical seal incorporates shrouded Rayleigh step-bearing lift pads to provide the self-acting property at 32000 RPM. Measurements of film thickness for a similar seal and for a spiral groove seal have been reported [18]. The fluid medium was air at room temperature and atmospheric pressure; there was zero pressure differential across the seal face. Test speed was 2000 to 17000 RPM; the seals operated at a tilt angle (i.e., faces not parallel). The dynamic behavior of the same seals has been further tested and reported [19]. A significant finding was that some seals exhibited two vibratory modes at distinct film thickness that were speed dependent. Below about 11,000 RPM a low amplitude mode was observed at a frequency of two times shaft speed. Above 11,000 RPM a high amplitude mode was observed at a frequency of four times shaft speed. These results [18, 19] might not be practically applicable, however, because the experi-

mental seal did not simulate a realistic seal with flexible support providing three degrees of freedom.

An experimental program in which the dynamic behavior of coned face seals operating in oil was observed has been reported [20]. Axial movement of the mating seal parts was recorded on a high speed data acquisition system; no attempt was made to calculate the angular tilts.

Film thickness measurements have been reported [4, 21]; no indication of the method used for measurement was given. From somewhat more detailed information [5, 22] it can be seen that the tested seal does not really simulate an actual seal on a flexible support. In an actual seal the flexibly mounted element has three degrees of freedom; i.e., it can move axially and tilt about two orthogonal diameters. In some of the test rigs described in the literature [18-22] one of the seal rings was mounted on a gimbal that provided only two degrees of freedom in the angular mode. Axial variation in the film thickness in these tests was due to a mating ring that had only the axial degree of freedom -- and is thus a completely different dynamic system than a practical seal. More attention will have to be given in future testing to the simulation of realistic seals. Experimental work to examine the effect of radial eccentricity on the angular stability of a seal has been reported [23].

A test program for studying dynamic behavior in the angular mode of a coned face seal operating in water has been described [24]. Relative misalignment between rotor and stator -- a key factor in seal performance -- was found; the effects of rotor runout and of the flexible support on relative misalignment were discussed. A lack of information on the dynamic properties of the flexible support (elastomer O-rings) does not allow meaningful correlation with theoretical prediction. An ongoing effort has been made at the Atomic Energy Commission of Canada [23, 24] to improve mechanical seals for nuclear main coolant pumps. A recently published review [25] would be of value to those interested in the subject.

CONCLUSION

Seal dynamics research has progressed to the point that various phenomena observed in the past can be explained theoretically. Experimental work is now required to confirm analytical predictions. The experiments should fully simulate actual seals. The flexibly mounted element of a mechanical face seal has three degrees of freedom, and its flexible support has both stiffness and damping characteristics. These facts should be applied to the design of test rigs for studying the dynamic behavior of mechanical seals. Both the dynamic properties of the flexible support and the amount of axial runout of the rotor and initial misalignment of the stator must be known before any comparison with theory can be made. Careful measurements of axial and angular motions of a flexibly mounted element must be performed in order to determine the relative misalignment between the mating faces of the seal. This misalignment is a key factor in predicting seal performance such as leakage, friction, and minimum film thickness.

As has been stated [26] the greatest need in mechanical seal area is design data. Proper seal design requires information on seal dynamics. A continuous effort along the lines pointed out above will yield the information necessary for better seal design.

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BOOK REVIEWS

STATE-OF-THE-ART SURVEYS ON FINITE ELEMENT TECHNOLOGY

A. Noor and W. Pilkey, Eds.
ASME, New York, NY
1983, 530 pages, $50.00

This book contains 16 papers and an extensive list of textbooks and monographs in the field of finite element technology. The papers are of three types: theoretical, expository, and survey. The nine theoretical chapters are lengthy treatises oriented to researchers in the finite element area. Included are discussions of a theoretical framework for proving existence and uniqueness theorems for the approximate problem; finite element basis functions, including polynomials, blending functions, and rational functions; higher-order, singular, mixed, and hybrid elements; nonlinear solution techniques (with extensive list of references); methods for efficient reanalysis necessitated by modified structural designs in static, dynamic, and eigenvalue problems; finite elements in the time domain; and a coupling of the finite element method with Rayleigh-Ritz and boundary element methods to solve problems containing regions that can make best use of the particular advantages of each technique.

The expositoty papers include discussions of the art of designing finite element meshes; some direct and iterative linear solution techniques; and sources, magnitudes, estimates, and control of solution errors in finite element analysis. The third group of papers presents surveys on large general purpose finite element software systems including prospects for further development; finite element pre-and post-processors; capabilities of specific finite element programs, from small programs for teaching and research to large general purpose programs; and advances in computer technology and architecture, special algorithms and programming languages, and future multidisciplinary, data base-managed, integrated engineering software systems.

Although the theoretical papers are oriented toward finite element researchers, the expository and survey papers offer the practicing finite element analyst insight into such areas as algorithms, sources of errors, and current availability and possible future trends of software. Many of the papers contain extensive lists of references as well as possible fruitful directions for future research.

Because the book is composed of papers written by 25 authors, comments related to writing style and format would not be meaningful. However, two other aspects should be mentioned. First, the editors state in the Foreword that the book was originally planned for publication in 1980 but was delayed until 1983. Although most of the papers were revised, some were not. In particular, two of the latter did not mention some important currently available software, and seven of the 16 papers contain no references after 1980. The second aspect relates to the editing process itself. A significant number of typographical errors were not corrected; many of the corrections that were made are in a font different from that of the original text. In addition, there were two instances of interchanged pages. Despite these problems, the book contains much good and useful information for researchers and practicing analysts in the finite element field.

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FAILURE OF MATERIALS IN MECHANICAL DESIGN

J.A. Collins
John Wiley and Sons, New York, NY
1981, 624 pages, $51.95

This textbook provides an excellent and comprehensive treatment of the subject of failure of materials. Its 17 chapters consist of more than 600 pages. The first six chapters provide appropriate background in basic engineering principles and theories of various types of failures that can occur in materials. These chapters provide the basic definitions of terms used in this field, descriptions of the modes of mechanical failure, background information in strength and deformation of engineering materials, an introduction to stress and strain covering both elastic and plastic concepts, and a thorough review of important combined stress theories of failure.

Chapters seven through 17 cover individual topics of material failure in complete, but not overwhelming, detail. Topics include high cycle fatigue, cumulative damage, life prediction, fracture control, statistics in fatigue analysis, fatigue testing procedures including statistical interpretation of data, low cycle fatigue, stress concentration, creep, stress rupture, fretting, shock, impact, buckling, wear, and corrosion. Most of these chapters contain a section on using the ideas that provides the reader with completely solved, practically based, example problems.

The book can be used as either a textbook for advanced undergraduate and beginning graduate courses in mechanical failure; a reference book for mechanical designers involved in engineering practice; or a resource for continuing education courses in material failure. For each of these purposes, the book should find wide acceptance as a basic treatise of the subject of engineering failure of materials.

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APPLICATIONS OF DISCRETE AND CONTINUOUS FOURIER ANALYSIS

H.J. Weaver
John Wiley and Sons, New York, NY
1983, 374 pages

Fourier analysis involves decomposing general functions into linear combinations of sines and cosines. The author divides Fourier analysis into three topics: Fourier series maps and a sequence of Fourier series coefficients; Fourier transform maps; and discrete Fourier transform mapping. One of the features of the Fourier transform is that it can be used to digitally calculate either of two mappings. As stated by the author, "My intention . . . was to produce a work that would enable the reader to understand the properties and concepts of the Fourier mappings and then apply this knowledge to the analysis of real scientific and engineering problems."

The book contains 11 chapters. The first chapter introduces sine and cosine functions, amplitude, frequency, phase, and the concept of the complex variable and its frequency content.

Chapter 2 covers Fourier series in terms of frequency content, periodic functions, and Fourier series in complex functions. It concludes with Fourier series of odd and even functions. The next chapter introduces Fourier transforms. It encompasses the properties and frequency content of the Fourier transform, Gaussian function, symmetric relations, and the impulse function. The relationship of convolution and cross correlation and two dimensional Fourier transforms, including convolution, are given.

Chapter 4 has to do with the discrete Fourier transform including properties, nth order relations, symmetry relationship, and simultaneous calculation of real transforms. The latter part of the chapter describes the fast Fourier transform (FFT) and the mixed radix fast transforms. The reviewer would prefer a computer program that shows application of the FFT.

The next chapter describes Fourier analysis with the digital computer. Sampling a function and computing the calculated Fourier series and Fourier transforms are described as are comb functions -- in essence an infinite train of equally spaced impulse functions. The author covers super-gaussian windows for data analysis but passes lightly over the widely used Kaiser, Hamming, and Hanning windows; the reviewer believes that more detailed information should be given as to their shortcomings and that any advantages of the super-gaussian window should be elaborated.

Chapter 6 is concerned with systems and transfer functions in the frequency domain including the impulse response and transfer function of a system. Chapter 7 covers vibrational systems. The transfer functions of mechanical and electrical systems are considered as is the transverse vibration of a finite and infinite string. The reviewer feels that this chapter is too short. No mention is made of experimental modal analysis; the root locus theory applied to vibration theory is not mentioned. Acoustics is completely ignored, yet the Helmholtz equation is derived for string vibration.

In Chapter 8 on optics the author describes the Fresnel diffraction equation and its use as a Fourier transform. Thin lenses, imaging properties, diffraction, coherent and incoherent systems, and resolution of optical systems are discussed, as are spatial filtering and sampling theory with optics application.

The next chapter on numerical analysis includes a number of algorithms --nonrecursive and nonrecursive smoothing, derivative and recursive -- a review of finite difference, integration and interpolation algorithms, and nonrecursive filters in the time domain. They are the Fourier series components of a transfer function.

Chapter 10 is a brief introduction to heat transfer. The author derives the heat equation and shows how finite sine and cosine transforms are used to solve it. The equation is applied to one- and two-dimensional steady-state and transient heat flow in finite bodies. The reviewer feels that this chapter should be expanded to include computer programs that facilitate the application of Fourier analysis to heat transfer.

The final chapter focuses on stochastic analysis. Topics are a review of statistics, probability and correlation theory, moments and central limit theories, convolution and probability distributions, autocorrelation and random signals, ensembles and expected values of a random signal, stationary signals, and the ergodicity principle. The reviewer feels this chapter is too short.

This is a good book. A number of sections are too short. No mention is made of cepstrum analysis, and little information on data processing of stochastic applications is included. Computer programs would be helpful. This book could be used by the beginner but requires more than casual reading. Experienced personnel might find applications that they had never before considered or thought about.

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1 Arcadian Drive
Scotia, NY 12302

MODAL TESTING AND MODEL REFINEMENT

D.F.H. Chu, Ed.
ASME, New York, NY
AMD - Vol. 59, 1983, 154 pages, $34.00

Modal testing plays an important role in the design and development of mechanical structures. The art of modal testing has expanded tremendously and requires proper testing tools and interpretation of the data. This conference, held at the 1983 ASME Winter Annual Meeting, attempts to improve modal testing and model refinement techniques.

The symposium consists of ten papers. The paper by Professor Allemang is an excellent review of experimental modal analysis. He presents the theoretical basis of four general approaches: forced normal mode

excitation, frequency response function, damped complex exponential function, and mathematical input-output model.

The next paper proposes a simple method for determining the system parameters of a structure by experimental means. Single-degree-of-freedom modes are used to formulate a multi-degree-of-freedom system. A physical space mathematical could be obtained by fitting the data to an inverse Nyquist plane and assembling the effective mass, stiffness, and damping by normal mode corrections. The authors describe a general case in which the number of degrees of freedom exceeds the number of modes.

The third paper considers a time domain linear model estimation technique for multiple input modal analysis. A more representative model can be obtained by developing a finite difference linear model that relates multiple inputs to multiple outputs for various damped mechanical structures. The model employs simultaneously all available input-output data. A global set of damped natural frequencies and damping values can be obtained by capturing the data.

The fourth paper covers the improved frequency response function circle fit. A poor frequency response function (FRF) results in a poor likeness of actual structural response regardless of the circle fit or the multi-modal fit. The authors investigate an alternative approach to obtaining the FRF that tends to be more accurate and furnishes an estimate at or around resonance. This alternate method does away with system errors by employing a simple revision of the procedure that treats the data in an FFT process in the vicinity of the resonance location.

The next paper discusses the modal analysis of a cylindrical shell with a longitudinal crack. The finite element method is applied, and a nonsingularity approach in crack extension is assumed; the natural frequencies and natural modes increase, and the modes have complicated shapes. Experimental results tend to verify analytical results.

The sixth paper has to do with modal testing and analysis. This informative paper states that a number of procedures used in semi-automating the correlation of frequency and mode shapes have been sound in hypothetical cases but falter when applied in practice. Correlation of resonant frequency might not improve the correlation of the modal force coefficients. Such known parameters as kinetic and strain energy could play more important roles.

The next paper treats modal improvement vs model manipulation, model limitations based on the scope of the model, and model uniqueness with regard to modeling assumptions and selection of experimental data. The authors use Bayesian statistical parameter estimation for dynamic model verification. Incorrect use of this method could result in an unreasonable model even though the model matches the data.

The eighth paper covers parameter identification of large structural models. The Bayesian approach is used; when applied to moderately sized FE models, the approach improves the model within the confines of the initial problem.

The next paper shortens the methods of refining FE models with localized uncertainties. Unsure parameters in the original models are altered to improve the correlation between measured and predicted natural frequencies. The modes are improved iteratively by solving a system of linear equations in an order equal to the number of modes used in the reanalysis.

The last paper shows the application of modal analysis in refinement of a shock tube design. An FE program is used to obtain the modal characteristics of a new breach design; proper design requirements are fulfilled to achieve the desired dynamic coupling. The goals of the organizers were met in this symposium.

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SHORT COURSES

MAY

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: May 6-10, 1985
Place: Boston, Massachusetts
Dates: June 3-7, 1985
Place: Santa Barbara, California
Dates: August 26-30, 1985
Place: Santa Barbara, California
Dates: December 2-6, 1985
Place: Santa Barbara, California

Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 -(805) 682-7171.

MACHINERY INSTRUMENTATION AND DIAGNOSTICS

Dates: May 6-10, 1985
Place: Carson, Nevada
Dates: June 4-7, 1985
Place: Pittsburgh, Pennsylvania
Dates: July 15-19, 1985
Place: Carson City, Nevada
Dates: September 10-13, 1985
Place: New Orleans, Louisiana
Dates: September 24-27, 1985
Place: Anaheim, California
Dates: October 8-11, 1985
Place: Philadelphia, Pennsylvania
Dates: October 21-25, 1985
Place: Carson City, Nevada
Dates: November 5-8, 1985
Place: Boston, Massachusetts
Dates: December 3-6, 1985
Place: Houston, Texas

Objective: This course is designed for industry personnel who are involved in machinery analysis programs. Seminar topics include a review of transducers and monitoring systems, machinery malfunction diagnosis, data acquisition and reduction instruments, and the application of relative and seismic transducers to various types of rotating machinery.

Contact: Customer Information Center, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9242.

ROTOR DYNAMICS

Dates: May 6-10, 1985
Place: Syria, Virginia

Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated. The fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MACHINERY INSTRUMENTATION
Dates: May 14-16, 1985
Place: San Francisco, California
Dates: June 25-27, 1985
Place: Denver, Colorado
Dates: November 12-14, 1985
Place: Calgary, Alberta, Canada
Objective: This seminar provides an in-depth examination of vibration measurement and machinery information systems as well as an introduction to diagnostic instrumentation. The three-day seminar is designed for mechanical, instrumentation, and operations personnel who require a general knowledge of machinery information systems. The seminar is a recommended prerequisite for the Machinery Instrumentation and Diagnostics Seminar and the Mechanical Engineering Seminar.

Contact: Customer Information Center, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9243.

JUNE

VIBRATION CONTROL
Dates: June 3-7, 1985
Place: San Diego, California
Objective: This vibration control course will include all aspects of vibration control except alignment and balancing. (These topics are covered in separate Institute courses.) Specific topics include active and passive isolation, damping, tuning, reduction of excitation, dynamic absorbers, and auxiliary mass dampers. The general features of commercially available isolation and damping hardware will be summarized. Application of the finite element method to predicting the response of structures will be presented; such predictions are used to minimize structural vibrations, during the engineering design process. Lumped mass-spring-damper modeling will be used to describe the translational vibration behavior of packages and machines. Measurement and analysis of vibration responses of machines and structures are included in the course. The course emphasizes the practical aspects of vibration control. Appropriate case histories will be presented for both isolation and damping.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

TIME DOMAIN MODAL VIBRATION TESTING TECHNIQUES
Dates: June 6-7, 1985
Place: Virginia Beach, Virginia
Objective: The seminar presents an in-depth study of the Ibrahim Time Domain (ITD) method, examining results of previous applications and the applied use of the computer program and its selected options. Through attendance at the workshop, participants will receive the complete computer program of the ITD method and should be able to use the technique in modal vibration testing applications.

Contact: Mr. W.C. Bentley, Industrial Programs, School of Engineering, Old Dominion University, Norfolk, VA 23508 - (804) 440-4243.

VIBRATION DAMPING
Dates: June 16-20, 1985
Place: Dayton, Ohio
Objective: The utilization of the vibration damping properties of viscoelastic materials to reduce structural vibration and noise has become well developed and successfully demonstrated in recent years. The course is intended to give the participant an understanding of the principles of vibration damping necessary for the successful application of this technology. Topics included are: damping fundamentals, damping behavior of materials, response measurements of damped systems, layered damping treatments, tuned dampers, finite element techniques, case histories, and problem solving sessions.

Contact: Michael L. Drake, Jesse Philips Center 36, 300 College Park Avenue, Dayton, OH 45469 - (513) 229-2644.

JULY

MECHANICS OF HEAVY-DUTY TRUCKS AND TRUCK COMBINATIONS

Dates: July 15-19, 1985
Place: Ann Arbor, Michigan
Objective: This course describes the physics of heavy-truck components in terms of how these components determine the braking, steering, and riding performance of the total vehicle. Covers analytical methods, parameter measurement procedures, computational and test procedures, useful for performance analysis prediction and design.

Contact: Continuing Engineering Education, College of Engineering, The University of Michigan, Chrysler Center/-North Campus, Ann Arbor, MI 48109-2092 - (313) 764-8490.

AUGUST

BASICS OF VIBRATION DAMPING TECHNOLOGY

Dates: August, 1985
Place: Dayton, Ohio
Objective: A four day intensive seminar/workshop on basic damping technology, including viscoelastic material behavior, nomograms for representing effects of frequency and temperature on real material behavior, single degree and multiple degree of freedom systems, free layer, constrained layer and discrete damping techniques, and measurement basics will be given. Highlights include a new textbook on vibration damping, extensive use of participant exercises, worksheets and calculator applications to reinforce the learning process, and detailed evaluation of case histories. Attendance will be strictly limited to ensure an intensive and interactive work experience.

Contact: Dr. D. Jones, Damping Technology Information Services, Box 33514, Wright-Patterson AFB, OH 45433-0514.

MECHANICAL ENGINEERING

Dates: August 12-16, 1985
Place Carson City, Nevada
Objective: This course is designed for mechanical, maintenance, and machinery engineers who are involved in the design, acceptance testing, and operation of rotating machinery. The seminar emphasizes the mechanisms behind various machinery malfunctions. Other topics include data for identifying problems and suggested methods of correction.

Contact: Customer Information Center, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9243.

MODAL TESTING OF MACHINES AND STRUCTURES

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MACHINERY VIBRATION ANALYSIS

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Objective: This course emphasizes the role of vibrations in mechanical equipment instrumentation for vibration measurement, techniques for vibration analysis and control, and vibration correction and criteria. Examples and case histories from actual vibration problems in the petroleum, process, chemical, power, paper, and pharmaceutical industries are used to illustrate

techniques. Participants have the opportunity to become familiar with these techniques during the workshops. Lecture topics include: spectrum, time domain, modal, and orbital analysis; determination of natural frequency, resonance, and critical speed; vibration analysis of specific mechanical components, equipment, and equipment trains; identification of machine forces and frequencies; basic rotor dynamics including fluid-film bearing characteristics, instabilities, and response to mass unbalance; vibration correction including balancing; vibration control including isolation and damping of installed equipment; selection and use of instrumentation; equipment evaluation techniques; shop testing; and plant predictive and preventive maintenance. This course will be of interest to plant engineers and technicians who must identify and correct faults in machinery.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

BALANCING OF ROTATING MACHINERY

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: This course will emphasize the practical aspects of balancing in the shop and field including training on basics, the latest techniques, and case histories. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one- and two-plane); field balancing; balancing machines and facilities; use of programmable calculators; turbine-generator balancing; balancing sensitivity; factors to be considered in high speed balancing; effect of residual shaft bow on unbalance; tests on balancing machines; flexible rotor balancing --training and techniques; a unified approach to flexible rotor balancing; and coupling balancing.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

VIBRATION MEASUREMENT AND MODAL ANALYSIS

Dates: August 15-17, 1985
Place: Amherst, New York
Objective: This course covering dynamic and measurement systems, dynamic signals, applied signal analysis, vibration fundamentals and applied modal analysis will provide engineers with a background in both fundamental and applied aspects of vibration and modal testing. The course will be taught in a lecture/demonstration format making considerable in-class use of state of the art signal analysis and modal analysis instrumentation. Hands on lab experience will be available through informal evening sessions.

Contact: Mike Murphy, Kistler Instrument Corporation, 75 John Glenn Drive, Amherst, NY 14120 - (716) 691-5100.

OCTOBER

VIBRATIONS OF RECIPROCATING MACHINERY

Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Objective: This course on vibrations of reciprocating machinery includes piping and foundations. Equipment that will be addressed includes reciprocating compressors and pumps as well as engines of all types. Engineering problems will be discussed from the point of view of computation and measurement. Basic pulsation theory --including pulsations in reciprocating compressors and piping systems -- will be described. Acoustic resonance phenomena and digital acoustic simulation in piping will be reviewed. Calculations of piping vibration and stress will be illustrated with examples and case histories. Torsional vibrations of systems containing engines and pumps, compressors, and generators, including gearboxes and fluid drives, will be covered. Factors that should be considered during the design and analysis of foundations for engines and compressors will be discussed.

Practical aspects of the vibrations of reciprocating machinery will be emphasized. Case histories and examples will be presented to illustrate techniques.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

Periodical articles, society papers, and papers presented at conferences may be obtained at the Engineering Societies Library, 345 East 47th Street, New York, NY 10017; or Library of Congress, Washington, D.C., when not available in local or company libraries.

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When ordering, the pertinent order number should always be included, not the **DIGEST** abstract number.

A List of Periodicals Scanned is published in issues, 1, 6, and 12.

MECHANICAL SYSTEMS

ROTATING MACHINES

85-653
Lateral Gear Shaft Dynamics Control Torsional Stresses in Turbine-Driven Compressor Train
H.R. Simmons, A.J. Smalley
Southwest Res. Inst., San Antonio, TX 78284
J. Engrg. Gas Turbines Power, Trans. ASME, 106 (4), pp 946-951 (Oct 1984), 10 figs, 3 tables, 6 refs

KEY WORDS: Compressors, Torsional response, Critical speeds, Damping coefficients

An experimental evaluation of a gas turbine/compressor train yielded excellent correlation between measured and predicted torsional critical speeds. Torsional strain signals acquired at a coupling location provided basic data from which damping factors at resonance varied from 1 to 6 percent. Resonant stress levels for the mode with low damping would be two times higher than predictions based on industry accepted assumptions. Other modes had considerably more damping than expected. Experimental data and a coupled torsional-lateral damped eigenvalue analysis showed that this damping variation was related to pinion and gear lateral bearing motion.

85-654
Impact Response of Rotor-Bearing System to an Arbitrary Excitation of Pedestals (2nd Report: Experiments on Rotor Vibration due to Various Types of Excitation)
H. Koike, K. Ishihara
Technical Inst., Kawasaki Heavy Industries, Ltd., Kawasaki-cho 1-1, Akashi, Japan
Bull. JSME, 27 (233), pp 2506-2513 (Nov 1984)

KEY WORDS: Rotors, Periodic excitation, Transient excitation, Base excitation

Vibration experiments on a rotor-bearing system were done for four types of excitation. Results were discussed with respect to nonlinear effects of the bearing oil film. Linearity to a large amplitude was shown. The nonlinear solution and the static deflection were compared.

85-655
Large Unbalance Vibration Analysis of Steam Turbine Generators
M.L. Adams, Jr.
Case Western Reserve Univ., Cleveland, OH
Rept. No. EPRI CS-3716, RP1648-5, 108 pp (Sept 1984)

KEY WORDS: Steam turbines, Unbalanced mass response, Tilt pad bearings

Analysis of subharmonic resonance to a sudden major imbalance in a turbine generator showed that, in many utility-scale units, only a relatively small increase in imbalance force will trigger such resonance in a rotor-bearing system. Pivoted-pad journal bearings have the ability to absorb much of these forces.

85-656
Wave Envelope and Infinite Element Schemes for Fan Noise Radiation from Turbofan Inlets
R.J. Astley, W. Eversman
Univ. of Missouri, Rolla, MO
AIAA J., 22 (12), pp 1719-1726 (Dec 1984), 16 figs, 12 refs

KEY WORDS: Fan noise, Sound waves, Wave radiation, Finite element technique

Finite element models are used to calculate radiated fan noise in the vicinity of turbofan inlets. The models involve conventional axisymmetric finite elements in an inner region close to the inlet. The far field is represented by infinite elements or wave envelope elements. Theory and results

are presented for the case with no mean flow. Comparisons of computed data with analytic solutions and measured values establish the utility of both the infinite element and wave envelope element schemes. The wave envelope scheme is effective in the far field. Both schemes use meshes.

85-657
Flutter and Forced Response of Mistuned Rotors Using Standing Wave Analysis
J. Dugundji, D.J. Bundas
Massachusetts Inst. of Technology, Cambridge, MA
AIAA J., 22 (11), pp 1652-1661 (Nov 1984), 8 figs, 3 tables, 13 refs

KEY WORDS: Rotors, Tuning, Flutter, Standing waves

Flutter and forced responses of a tuned and mistuned rotor are examined using a standing wave approach. The equations of motion are written in the standard matrix form, $Mx + Cx + Kx = F(t)$; M, C, K are real coefficients. Applications are given for vibration modes, flutter, and forced response.

METAL WORKING AND FORMING

85-658
Using a Scale Model to Investigate the Post Fracture Structural Vibrations and Noise of a 200 Tonne Power Press
G. Stimpson
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 835-844, 9 figs, 6 refs

KEY WORDS: Presses, Noise reduction

Detailed measurements on the actual press posed many practical problems; thus a simplified scale model of the structure was constructed. Advantage of the model was not only that it allowed detailed measurements to be made in the laboratory but it provided the capability to study the effects of structural modifications that would be totally impractical on the full-sized press.

MATERIALS HANDLING EQUIPMENT

85-659
State Space Approach to Mechanical Vibration
Hu Zongwu, Yan Junqi
Dept. of Mech. Engrg., Shanghai Jiao Tong Univ.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 151-160, 1 fig, 4 refs

KEY WORDS: Overhead cranes, State space approach

Theoretical basis, means of calculation, computer program, and main characteristics of the state space method are described in this paper. A mathematical model for the traveling mechanism of an overhead traveling crane was used to find the dynamic response of the system in different conditions. The method was stable and accurate for all time-varying loads.

85-660
Dynamic Response of Crane Structure
Wei-zhang Chen
Marine and Transportation Inst. of Shanghai
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 139-149, 4 figs, 4 refs

KEY WORDS: Cranes (hoists), Finite element technique, Lumped mass method

The dynamic response of crane structures was analyzed by transforming a crane structure of indefinite DOF into a space model with definite DOF by using finite element method and lumped mass method. Differential equations of free vibration can be derived; the subspace iteration method is used to solve the eigenvalue problem. The dynamic response of two phases can be calculated by the mode superposition method. The maximum dynamic and static inner forces of each end of every element and corresponding dynamic factors can be obtained.

STRUCTURAL SYSTEMS

BRIDGES

85-661
Observations on the Aerodynamic Excitation of a Suspension Bridge - Section Model Tests and Prototype Behavior
C.F. Scheffey
Ph.D. Thesis, The George Washington Univ., 204 pp (1984), DA8417858

KEY WORDS: Suspension bridges, Wind-induced excitation

This investigation concerns the Deer Isle Bridge in the State of Maine, a suspension bridge, that has been modified by a complex arrangement of diagonal stays. It was necessary to develop a specialized matrix formulation of the structural system. A limited series of live load tests on the prototype structure confirmed the general validity of the analysis. Episodes of Prototype behavior were analyzed and compared with model predictions. The existence of a mixture of vertical and torsional motion illustrates the hazard of oversimplification of response models.

85-662
Fatigue Investigation of a Railway Truss Bridge
Z.L. Szeliski, I.A. Elkholy
CN Rail, Montreal, P.Q., Canada H3B 2M9
Can. J. Civ. Engrg., 11 (3), pp 625-631 (Sept 1984), 9 figs, 10 tables, 5 refs

KEY WORDS: Railroad bridges, Fatigue life

A description of a fatigue investigation of a 35.7 m (117 ft) railway truss span is presented. The study consisted of field measurement; theoretical model analysis; traffic analysis; estimate of fatigue damage; evaluation of fatigue detail category; estimate of remaining life; and action required. The effect of car sequence in trains, sample size, flat wheels, and impact on level of stresses is examined. As a result of the study, the trusses were retrofitted by removing rivets, reaming holes, and placing high-strength bolts.

85-663
Traffic Loads on Medium and Long Span Bridges
D.J. Harman, A.G. Davenport, W.S.S. Wong
The Univ. of Western Ontario, London, Ontario, Canada N6A 5B9
Can. J. Civ. Engrg., 11 (3), pp 556-573 (Sept 1984), 13 figs, 16 refs

KEY WORDS: Bridges, Traffic-induced vibrations

A procedure is described for calculating the mean and the coefficient of variation for largest live load effects in a bridge structure caused by highway traffic during a reference period. These statistics are pertinent in the selection of highway live loads and calibration of a statistically based design code. The reference period depends on the limit state being calibrated. More concise procedures for simulation and calculation are recommended.

85-664
Inelastic Analysis of Short Highway Bridges Subjected to Strong Ground Motions
M. Saiidi, J.D. Hart, B.M. Douglas
Univ. of Nevada, Reno, NV

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 599-608, 10 figs, 12 refs

KEY WORDS: Bridges, Seismic excitation, Foundations, Elastomeric bearings

Static and dynamic nonlinear modeling of short highway bridges subjected to lateral loads are discussed. The behavior of inelastic bridge components, is reviewed. Two hysteresis models were used. Calculated and measured static and free-vibration response of a five-span bridge are presented. No universally accepted method to determine the basic nonlinear properties of pile foundations and elastomeric bearing pads is available.

BUILDINGS

85-665
Statistical Analysis of the Inelastic Response of Shear Structures Subjected to Earthquakes
G. Rega, F. Vestroni
Istituto di Scienza delle Costruzioni, Univ. of L'Aquila, Monteluco-Roio, 67100 L'Aquila, Italy
Earthquake Engrg. Struc. Dynam., 12 (6), pp 833-846 (Nov/Dec 1984), 13 figs, 6 tables, 18 refs

KEY WORDS: Multistory buildings, Seismic response, Statistical analysis

To gain a better insight into the seismic behavior of multi-degree-of-freedom structures beyond the elastic range, the dynamic elasto-plastic response of a ten-story shear system under two sets of artificial and recorded accelerograms is studied Different stiffness-strength distributions and constitutive laws are considered. Statistics of the results demonstrate the dependence of overall and story ductility values and of their ratio on the characteristics of the structure and excitation.

85-666
A Higher Order Continuum Model for the Dynamic Shear Behaviour of Multi-Storey Frames
C. Dundar, Y. Mengi, E. Kiral
Cukurova Univ., Adana, Turkey
Earthquake Engrg. Struc. Dynam., 12 (6), pp 761-775 (Nov/Dec 1984) 3 figs, 4 tables, 5 refs

KEY WORDS: Multistory buildings, Continuum mechanics, Natural frequencies, Mode shapes

A continuum model is developed to predict the response of multi-story frames to dynamic excitations. The equations of the proposed theory are derived in a systematic manner using smoothing operations. The order of the theory is kept arbitrary. Natural frequencies and vibration shapes predicted by discrete and continuum models are compared. The most crucial finding is that an effective height equal to the height of the frame plus half the height of the top story should be defined. The number of modes the continuum model can describe correctly increases with the number of storys.

85-667
A Numerical Model for Seismic Analysis of Masonry Buildings: Experimental
D. Benedetti, G.M. Benzoni
Politecnico di Milano, Milan, Italy
Earthquake Engrg. Struc. Dynam., 12 (6), pp 817-831 (Nov/Dec 1984) 14 figs, 7 tables, 14 refs

KEY WORDS: Buildings, Masonry, Seismic response

A nonlinear finite element model for plain masonry structures under lateral static loads and seismic base inputs is presented. Three super-imposed elasto-plastic shear elements are used to approximate a typical force-displacement curve for masonry. Material properties are identified with respect to results of shear tests on single piers. Modeling of entire structures is performed; the numerical results satisfactorily check against static and shaking table

tests of simple buildings. Out-of-plane behavior of walls is accounted for by a simplified method.

85-668
Inelastic Seismic Analysis of a Building Structure Designed by Argentine Codes
V.E. Sonzogni, A. Cardona, S.R. Idelsohn
INTEC, Casilla de Correo No. 91, 3000-Santa Fe, Argentina
Earthquake Engrg. Struc. Dynam., 12 (6), pp 721-736 (Nov/Dec 1984) 12 figs, 2 tables, 12 refs

KEY WORDS: Buildings, Reinforced concrete, Seismic design, Standards and codes

A reinforced concrete frame-wall structure of a building designed in accordance to standard practice in Argentina was analyzed using procedures prescribed by current Argentine Codes. Inelastic step-by-step response of the structure to design spectrum-compatible accelerograms was studied by a special element for inelastic dynamic analysis of reinforced concrete frames. Results obtained by the different methods are presented.

85-669
Seismic Response for Multicomponent Earthquakes
M. Ghafory-Ashtiany
Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 250 pp (1984) DA8418218

KEY WORDS: Seismic response spectra

The main purpose of this study is to consider the six components of earthquake motions in structures and their correlations in calculating design response. The response of a structure is shown to depend upon the orientation of the structure with respect to impinging seismic waves. A methodology is developed to obtain the worst case response, irrespective of the orientation of the structure. Numerical results demonstrating the applicability of the methodology are presented. It is also shown that the effect of rotational components can be significant for tall and large structures.

FOUNDATIONS

85-670
Soil-Structure Interaction under Dynamic Loads
L.M. El-Hifnawy
Ph.D. Thesis, Univ. of Western Ontario, Canada (1984)

KEY WORDS: Soil-structure interaction, Foundations, Seismic response, Wind-induced excitation

A theoretical study of soil-structure interaction effects on the dynamic behavior of structures is presented. A substructure approach is employed; both rigid and flexible structures supported by various types of foundations are investigated. Dynamic responses of the soil-structure interaction system excited by shock, earthquake, and wind loading are investigated. The response of rigid structures to seismic loading is dealt with using the direct random vibration analysis. The effect of foundation flexibility on structural response to gusting wind is explored using the gust factor approach.

85-671
Dynamic-Stiffness Matrix of Embedded and Pile Foundations by Indirect Boundary-Element Method
J.P. Wolf, G.R. Darbre
Electrowatt Engrg. Services Ltd., 8022 Zurich, Switzerland
Nucl. Engrg. Des., 80 (3), pp 331-342 (Aug 1, 1984) 15 figs, 6 refs

KEY WORDS: Pile foundations, Soil-structure interaction, Boundary element technique, Matrix methods

The boundary-integral equation method is well suited for the calculation of the dy-

namic-stiffness matrix of foundations embedded in a layered visco-elastic half-space which represents an unbounded domain. Distributed source loads of initially unknown intensities act on a source line located in excavated soil and are determined such that the prescribed boundary conditions on the structure-soil interface are satisfied in an average sense. Accurate results are obtained with a small number of load parameters acting on a source line coinciding with the structure-soil interface.

85-672
Static and Dynamic Behavior of Pile Groups
B.E.A. El-Sharnouby
Ph.D. Thesis, Univ. of Western Ontario, Canada (1984)

KEY WORDS: Pile foundations

Dynamic field experiments and limited static tests with 102 piles are described. Results verify the linear theories accounting for pile-soil-pile interaction. Experimental data for vertical and horizontal excitation are compared with theoretical predictions. A method presented allows for an arbitrary soil profile, pile type and configuration, and evaluates group stiffness, forces on individual piles, and material damping. Results of direct analysis agree with those of field experiments and other direct methods.

CONSTRUCTION EQUIPMENT

85-673
Dynamic Analysis of Wheel-type Earthmoving Vehicles (1st Report, Behavior of the Chassis Frame under Running)
H. Ito, M. Hasegawa, K. Kawai
Technological Univ. of Nagaoka, Nagaoka, Japan
Bull. JSME, 27 (233), pp 2514-2520 (Nov 1984) 12 figs, 1 table, 2 refs

KEY WORDS: Earth handling equipment

This paper deals with the behavior of a motor grader and a simulation working model. Results of a dynamic analysis based on this model were in good agreement with experimental values. Dynamic load and deformation of the frame were determined.

85-674
Noise Energy Radiated from Rod-Like Structures
L.C. Chow, J.M. Cuschieri
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 825-834, 2 figs, 1 tables, 6 refs

KEY WORDS: Rock drills, Rods, Noise generation

Using an energy concept, the noise radiated from a solid hexagonal rod and a tubular rod is investigated to obtain the parameters that influence the radiated noise. The operation of the drill is a consecutive series of impacts on the drill road, thus the tailoring of this impact is investigated for noise control and drilling efficiency.

POWER PLANTS

85-675
A Comparative Study of Soil Spring and Finite Element Models Application to Nuclear Power Station
K.M. Ahmed
National Nuclear Corp., Ltd., Booths Hall, Knutsford, Cheshire, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of

Southampton, Vol. I, pp 127-137, 8 figs, 5 refs

KEY WORDS: Nuclear power plants, Seismic response, Soil-structure interaction, Finite element technique

The objective of the study is to assess the degree of conservatism in the seismic response of nuclear power stations. It is based on an analysis using linear soil coupling springs and dampers. The results obtained in these non-linear analyses were compared to those with linear springs.

VEHICLE SYSTEMS

GROUND VEHICLES

85-676

A State Space Approach to the Analysis of Nonstationary, Nonlinear Random Vibration with Particular Application to the Problem of Vehicles on Rough Ground

R.F. Harrison, J.K. Hammond

Inst. of Sound and Vib. Res., Univ. of Southampton

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 673-680, 2 figs, 4 refs

KEY WORDS: Ground vehicles, Pavement roughness, State space approach

The dynamic response of vehicles to uneveness in the underlying surface on which they are travelling is of engineering interest. Structural integrity, safe handling, and a comfortable ride are considered. The problem has therefore received a great deal of attention in the literature over a number of years. This paper presents a unified approach on nonstationary, nonlinear vehicle problems.

85-677

Representation of Primary Suspensions of Rail Vehicles and Performance of Radial Trucks

T. Fujioka, Y. Suda, M. Iguchi

Tokyo Univ., Hongo, Bunkyo-ku, Tokyo, Japan

Bull. JSME, 27 (232), pp 2249-2257 (Oct 1984) 13 figs, 2 tables, 7 refs

KEY WORDS: Suspension systems (vehicles), Railroad cars

This paper considers improvement in the stability and handling performance of a truck. It is shown that all possible inner-truck suspensions are characterized by four independent stiffnesses and two geometric parameters. By use of the linear approach to dynamic stability and curve negotiation, the performance of a truck with an anti-yaw damper and connections between a truck frame and a wheelset are calculated.

85-678

Simulation of Hunting of Rail Vehicles (1st Report: Dynamic Models with Clearances in Various Parts and Transient Phenomena)

T. Hirotsu, Y. Morita, F. Iwasaki, S. Ishida

Hitachi Res. Lab., Hitachi Ltd., Katsuta, Japan

Bull. JSME, 27 (232), pp 2241-2248 (Oct 1984) 10 figs, 1 table, 5 refs

KEY WORDS: Railroad cars, Hunting motion

Dynamic models of four axle vehicles with two-axle bogies that make allowance for clearances and nonlinear elements have been set up. Some numerical examples made by varying values of wheel-rail adhesion coefficient and values of clearances are given.

85-679

Dynamic Modelling of Railway Track and Wheelsets

S.L. Grassie

Dept. of Engrg., Univ. of Cambridge, UK

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 681-698, 10 figs, 40 refs

KEY WORDS: Rail-vehicle interaction

The purpose of this paper is to discuss some of the developments which have been made in modeling a vehicle/track system. The results and conclusions drawn from these investigations are given. The emphasis here is on vertical dynamic response. Consideration is also given to lateral and longitudinal dynamics.

85-680
Two Theoretical Models for Wave Propagation in Rails
S. Scholl
Institut f. Technische Akustik, Technische Universität Berlin
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 699-707, 5 figs, 6 refs

KEY WORDS: Railroad tracks, Sound waves, Wave propagation

The intention of this paper is to give a basic survey on wave propagation in rails under idealized conditions. The complete three-dimensional description was considered to be too voluminous. Two simpler models were developed. They are two-dimensional and supplement each other.

85-681
Dynamics and Stability of Train-Track-Systems
R. Bogacz, K. Popp
Inst. of Fundamental Technological Res., Polish Academy of Sciences, Warsaw, Poland
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 709-721, 5 figs, 1 table, 24 refs

KEY WORDS: Rail-vehicle interaction

The aim of this paper is to introduce several linear and nonlinear models for train-track-systems and to investigate their dynamical behavior. The models are useful to examine the vertical dynamics as well as the lateral dynamics. The stability analysis for linear system is performed by investigating the roots of the resulting characteristic equation. Critical travelling speeds can be calculated depending on the system parameters. Explicit results are obtained in the case of vanishing damping.

85-682
Assessment of the Generating Mechanisms and Characteristics of Wheel/Rail Noise Via Study of a Rolling Disc
N.S. Ferguson, R.G. White
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 723-730, 4 figs, 12 refs

KEY WORDS: Rail-wheel interaction, Noise generation, Disks, Flexural vibrations

This study describes models of the wheel as a thin disc and is concerned with the excitation and response of the disc in flexural vibration.

85-683
On the Acoustically Optimal Design of Railway Wheels
H. Irretier, O. Mahrenholtz
Institut f. Mechanik, Universität Hannover

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 731-747, 14 figs, 3 tables, 25 refs

KEY WORDS: Railroad wheels, Noise generation, Design techniques

In the present study the radiated sound pressure and power of a wheel disk due to axial harmonic excitation at one point at the rim is calculated. On the basis of the subjective human feeling of sound pressure the radiated sound power is determined. Acoustical quality factors for the various types of wheel disks are specified.

SHIPS

85-684
Real Time Prediction of Ship Hull Vibration
J.W. Taylor
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA
64 pp (June 1984) AD-A144 791

KEY WORDS: Ship hulls, Vibration prediction, State space approach

State space models describing the energy spectrum of the sea, the surface of the sea over an area, and a ship hull are developed. These models are used to find a Kalman Filter that will estimate the deflection of the ship hull from noisy measurements of several points along the hull. Various models for predicting the future deflections of the hull are tested.

85-685
Added Mass and Damping of Rectangular Bodies Close to the Free Surface
J.N. Newman, B. Sortland, T. Vinje
Massachusetts Inst. of Tech., Cambridge, MA
J. Ship Res., 28 (4), pp 219-225 (Dec 1984) 11 figs, 7 refs

KEY WORDS: Submerged structures, Damping coefficients

A submerged two-dimensional rectangle inn calm water with infinite depth is studied. The rectangle is oscillating in a heave motion. Negative added mass and sharp peaks in the damping and added-mass coefficients have been found when the submergence is small and the width of the shallow region on top of the rectangle is large. A linear theory is developed to provide a relatively simple explanation of the occurrence of negative added mass for submerged bodies. The results from this theory are compared with numerical results from the Frank method. The importance of the interaction effect between the top and the bottom of the body, which is neglected in the present theory, is discussed.

AIRCRAFT

85-686
Airport Noise Impact Prediction and Measurement
A.T. Stoddard, III
Ph.D. Thesis, Cornell Univ., 244 pp (1984) DA8415413

KEY WORDS: Aircraft noise, Airports, Noise measurement, Noise prediction

This study presents a new, improved method of measuring noise impact and of estimating the changes which will result from noise mitigation efforts. Previous methods have been based on the notion of human annoyance. However, noise alone is not annoying, but becomes annoying when it interferes with human activities. Therefore, this study bases the prediction of noise impact on activity interference.

85-687
Analytical Investigation of Synchrophasing as a Means of Reducing Aircraft Interior Noise

C.R. Fuller
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA
Rept. No. NASA-CR-3823, 42 pp (Aug 1984) N84-32123

KEY WORDS: Aircraft noise, Interior noise, Noise reduction

The noise control characteristics of synchrophasing are investigated using a simplified model of an aircraft fuselage. The analysis presented here includes directivity effects of the noise sources. Variation in sound pressure level at various locations inside the shell is studied for various synchrophase angles as well as shell vibrational response and input power flow to uncover principal mechanisms behind transmission phenomena.

85-688
Aeroelastic Effects in Multi-Rotor Vehicles with Application to a Hybrid Heavy Lift System. Part 1: Formulation of Equations of Motion
C. Venkatesan, P. Friedman
California Univ., Los Angeles, CA
Rept. No. NASA-CR-3822, 145 pp (Aug 1984), N84-31216

KEY WORDS: Aircraft, Mathematical models, Equations of motions, Aeroelasticity

This report presents a set of governing coupled differential equations for a model of a hybrid aircraft. The model consists of multiple rotor systems connected by an elastic interconnecting structure. It has options to add any combination of or all of the following components, thrusters, a buoyant hull, and an underslung weight.

85-689
Structural Optimization of an Aircraft Design with Respect to Aspects of Aeroelastic Flutter Stability (Strukturelle Optimierung eines Flugzeugentwurfs unter Berücksichtigung aeroelastischer Flatterstabilitätsaspekte)
R. Freymann
Institut f. Aeroelastik der Deutschen Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt (DFVLR), Bunsenstrasse 10, D-3400 Göttingen
Z. Flugwiss. Weltraumforsch., **8** (3), pp 208-217 (May/June 1984), 6 figs, 1 table, 8 refs

KEY WORDS: Aircraft, Flutter, Optimum design

A new method is presented for use in the preliminary design of an aircraft in order to minimize structural weight. Aeroelastic flutter stability as well as strength requirements are taken into account. The practical application of the method is illustrated using a cantilevered large aspect ratio model wing structure as an example.

MISSILES AND SPACECRAFT

85-690
Radial SI Latches Vibration Test Data Review
P.M. Harrison, J.L. Smith
NASA George C. Marshall Space Flight Ctr., Huntsville, AL
Rept. No. NASA-TM-86454, 67 pp (July 1984), N84-31638

KEY WORDS: Spacecraft components, Vibration tests, Experimental data

Dynamic testing of the Space Telescope Scientific Instrument Radial Latches was performed as specified by the designated test criteria. No structural failures were observed during the test. The alignment stability of the instrument simulator was within required tolerances after testing. This report covers criteria derivation, testing, and test results.

85-691
Development of the Aerospace Structures Technology Damping Design Guide

J. Soovere, M.L. Drake, V.R. Miller, L.C. Rogers
Lockheed-California Co.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 867-875, 10 figs, 1 table, 13 refs

KEY WORDS: Spacecraft, Viscoelastic damping

This paper provides a brief outline of a program which capitalizes on viscoelastic damping technology. All of the pertinent information is brought together in a damping design guide. For a wide appeal, the design guide must be suitable for use by designers.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

85-692
A New Dynamic Vibration Absorber for Excited Structures (Ein neuer dynamischer Schwingungsdämpfer f.schwingungserregte Strukturen
H.F. Bauer
Hochschule der Bundeswehr München, Institut f. Luftfahrt u. Raumfahrttechnik, Fed. Rep. Germany
Forsch. Ingenieurwesen, 50 (4), pp 105-116 (1984), 10 figs, 18 refs (In German)

KEY WORDS: Dynamic vibration absorption (equipment), Wind-induced excitation

Structural systems are very susceptible to wind-excited oscillations. There exist not many effective systems to dampen the dangerous motion of the structure. The more effective vibration absorbers have some disadvantages such as the adjustment, blockage and servicing. They can therefore not be employed in space structures. This paper suggests a new damping device consisting of a completely filled liquid container filled with two immiscible liquids The effectiveness is exhibited for the coupled structure-liquid system. The system shows good results in preventing structural motion.

85-693
Acoustic Applications of Wood Wool Cement Slabs
A.N. Burd
Sandy Brown Associates, 1 Coleridge Gardens, London NW6 3QH, UK
Appl. Acoust., 17 (6), pp 439-451 (1984), 7 figs, 1 ref

KEY WORDS: Absorbers (materials), Sound waves, Wave absorption

Wood wool cement slabs, which are available in a variety of different forms, have proved to be effective for many acoustic applications. Some recent examples are described and compared with the expected behaviour based on laboratory measurements of absorption coefficients or sound reduction indices. Field results are shown for comparison where these are available.

85-694
Suspension Analysis and Self-Levelling
Auto Engr. (UK), 9 (2), pp 33-35 (Apr/May 1984), 10 figs

KEY WORDS: Suspension systems (vehicles)

It has been pointed out that the self-levelling solution can be a relatively expensive one for suspension systems. Adjustable dampers are carried out by fully collapsing the damper and rotating the dust cap until the cams of the nut engage the recesses of the foot valve assembly are described.

85-695
Dynamic Analysis of Vehicles with Nonlinear Suspension Properties

J.A. Lyons, L. Minnetyan
Clarkson College of Technology, Potsdam, NY 13676
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 665-672, 3 figs, 8 refs

KEY WORDS: Suspension systems (vehicles), Aircraft, Nonlinear systems

The analysis of complicated structural systems with both linear and nonlinear components by a conventional direct time-history integration of the equations of motion presents a formidable computational problem. The nonlinear force-displacement behavior of one or more of the structural components may necessitate the reformulation as well as the solution of the system equations of motion at each time step. For many practical structures, the computational effort required is often too great to facilitate an economical solution. Clearly, a more efficient procedure would be of value. In this work, one such method is presented. Results of an investigation of its use in solving a typical problem in the analysis of a particular class of structural systems are given.

85-696

Vibrational Power Transmission from a Short Source Beam to a Long Finite Receiver Beam via a Vibration Isolator

R.J. Pinnington
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 55-60, 8 figs, 3 refs

KEY WORDS: Vibration isolators, Machinery vibration, Flexible foundations

In this paper the higher frequency vibration is considered, where the machine can vibrate in the natural modes of vibration. For simplicity the machine is represented by a simple free-free beam excited at one end. This is connected at the undriven end via a rubber spring to long finite beam. This configuration was chosen as the analysis renders a simple algebraic solution for the frequency average power transmission. The results are more generally applicable, as the solution requires only the frequency average mobility of the two systems at the coupling point.

85-697

Reduction of Seismic Loads in Cable Tray Hangers

B.K. Pearce, J.E. Jackson, M.W. Dixon, F.R. Bourne
Clemson Univ., Clemson, SC 29631
Nucl. Engrg. Des., 81 (3), pp 403-410 (Sept 11, 1984) 5 figs, 2 tables, 13 refs

KEY WORDS: Cable hangers, Elastic supports, Seismic design, Nuclear power plants

A study has been conducted to partially assess the feasibility of using flexible rather than rigid support systems for carrying electrical and control cables in nuclear power plants. Using analytical and experimental studies, it was found that a flexible hanger design with appropriate stiffness and damping characteristics could be used to isolate trays from hanger vibration. Finite element techniques were used to select a flexible connector for a specified base hanger system. Tests were conducted on one-third-scale models to establish values for some of the parameters and to partially verify the analytical methods.

BLADES

85-698

A Finite Element for Vibration Analysis of Twisted Blades Based on Beam Theory

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Stevens Inst. of Tech., Hoboken, NJ
AIAA J., 22 (11), pp 1646-1651 (Nov 1984) 7 figs, 1 table, 11 refs

KEY WORDS: Blades, Beams, Finite element techniques, Natural frequencies

A finite element method of discretizing beam segments of pretwisted rotating blades is presented. Employing the matrix displacement method, stiffness and mass properties are developed from basic mechanics of a pretwisted beam theory. Illustrative examples are given comparing numerical results with available data and other numerical solutions from rotating and nonrotating force fields. These examples show that accurate prediction of vibration frequencies for pretwisted blades can be obtained by employing a quite modest number of degrees of freedom.

85-699
Flutter of Turbofan Rotors with Mistuned Blades
K.R.V. Kaza, R.E. Kielb
NASA Lewis Res. Ctr., Cleveland, OH
AIAA J., 22 (11), pp 1618-1625 (Nov 1984) 6 figs, 2 tables, 9 refs

KEY WORDS: Blades, Turbofans, Tuning, Hamiltonian principle

A set of aeroelastic equations describing the motion of an arbitrarily mistuned rotor with flexible, pretwisted, nonuniform blades is developed using an extended Hamilton's principle. The derivation of the equation has its basis in the geometric nonlinear theory of elasticity in which the elongations and shears are negligible compared to unity. A general expression for foreshortening of a blade is derived and is explicitly used in the formulation. Results indicate that a moderate amount of intentional mistuning has enough potential to alleviate flutter problems in unshrouded, high-aspect-ratio turbofans.

85-700
Analysis of Dynamic Stress Characteristics of Hollow Shell Type Blades
J. Thomas, S.H. Abdulrahman
Dept. of Mech. Engrg., Univ. of Surrey, Guildford, Surrey, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 189-198, 7 figs, 3 tables, 13 refs

KEY WORDS: Turbine blades, Shells, Fatigue life

A superparametric parabolic shell element specially adapted for dynamic conditions is utilized to analyze the vibration characteristics and dynamic stresses in a hollow aerofoil and symmetrical shell type turbine blades. The efficiency of the element developed is investigated and is shown to be superior to other available elements. Various results are presented to establish the dependence of the frequency on the geometric parameters.

85-701
Parametric Vibration in Large Blades Rotating in a Gravitational Field
A.D.S. Barr, T. Webster
Univ. of Dundee, Scotland
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 351-360, 6 figs, 3 refs

KEY WORDS: Blades, Parametric vibration, Initial deformation effects

The linearized equations of motion for a slender beam rotating in a gravitational field have been derived and examined in some detail for the special case of a light beam carrying an end mass. It has been shown that the zones of parametric instability of the beam may or may not be crossed as the rotational speed is increased depending on both the direction of the vibratory motion relative to the plane of rotation and the damping.

85-702
Instantaneous Interblade Pressure Distribu-

tions and Fluctuating Radial Thrust in a Single-Blade Centrifugal Pump
M. Aoki
Central Res. Lab., Ebara Corp., 4720 Fujisawa, Fujisawa-shi 251, Japan
Bull. JSME, 27 (233), pp 2413-2420 (Nov 1984) 15 figs, 8 refs

KEY WORDS: Rotor blades (turbomachinery), Centrifugal pumps, Radial vibrations

Although single-blade centrifugal pumps are frequently used to handle waste water with solids, they have poor durability because they show severe vibration caused by a fluctuating radial thrust. In this report, instantaneous blade surface pressure distributions affected by volute pressure distributions are measured on the suction cover surface of a pump with an open-type centrifugal impeller having one blade. The fluctuating radial thrust mechanism is then clarified on the basis of these measurements. A difference between actual radial thrust and the integrated value of static pressure along the impeller outlet is discussed.

85-703
Unsteady Aerodynamic Response of Cascades and Turborotors
V.G. Mengle
Ph.D. Thesis, Cornell Univ., 255 pp (1984) DA8415387

KEY WORDS: Rotor blades (turbomachinery), Aerodynamic loads

The unsteady aerodynamic forces due to arbitrary transient motions of the blades in an axial turborotor are studied by using linearized cascade theory. The mathematical techniques in single airfoil theory are extended to cascaded airfoils. Approximate expressions are obtained for the indicial and the oscillatory forces essential to applications in aeroelastic problems.

BEARINGS

85-704
Dynamic Characteristics of a Hydrostatic Gas Bearing Driven by Oscillating Exhaust Pressure
C.B. Watkins, H.D. Branch, I.E. Eronini
Howard Univ., Washington, D.C.
J. Tribology, Trans. ASME, 106 (4), pp 477-483 (Oct 1984) 7 figs, 2 tables, 17 refs

KEY WORDS: Gas bearings, Radial vibrations

Vibration of a statically loaded, inherently compensated hydrostatic journal bearing due to oscillating exhaust pressure is investigated. Both angular and radial vibration modes are analyzed. The time-dependent Reynolds equation governing the pressure distribution between the oscillating journal and sleeve is solved.

85-705
Squeeze Film Forces in a Magnetic Shaft Suspension System
L.D. Knox
Phillips Labs., North American Phillips Corp., Briarcliff Manor, NY 10510
J. Tribology, Trans. ASME, 106 (4), pp 473-476 (Oct 1984) 8 figs, 13 refs

KEY WORDS: Magnetic bearings, Squeeze-film bearings

Viscous squeeze film forces were studied as they pertain to a magnetic shaft suspension system (magnetic bearing). A nonrotating magnetically suspended shaft generates hydrodynamic fluid forces as it oscillates radially within a close fitting concentric cylinder. Experimental results from a scaled model verify the theoretical analysis. The study includes the finite and infinite length cases for large diameter to clearance ratios. The viscous squeeze film forces increase the phase margin in the magnetic bearing closed-loop control systems used in state-of-the-art cryogenic refrigerators.

85-706
Analytical Curve Fits for Solution Parameters of Dynamically Loaded Journal Bearings

P.K. Goenka
General Motors Res. Labs., Warren, MI 48090
J. Tribology, Trans. ASME, 106 (4), pp 421-428 (Oct 1984) 13 figs, 3 tables, 13 refs

KEY WORDS: Journal bearings, Curve fitting, Mobility method

The mobility method of solution is frequently used for analyzing dynamically loaded journal bearings. Curve fits of journal-bearing solutions are used in this method. All the currently available curve fits are lacking in one or more of three important features -- the solution accuracy, the solution detail, and the solution time. A new set of analytical curve fits is presented in this paper. An example is presented to demonstrate the use of the new curve fits.

85-707
Dynamically Loaded Journal Bearings: Finite Element Method Analysis
P.K. Goenka
General Motors Res. Labs., Warren, MI 48090
J. Tribology, Trans. ASME, 106 (4), pp 429-439 (Oct 1984) 12 figs, 3 tables, 16 refs

KEY WORDS: Journal bearings, Finite element technique

In this paper a finite element formulation for transient analysis of journal bearings is described. The formulation can be used for partial or full-arc bearings with oil-supply hole and oil-feed grooves, with tapered or misaligned journal, and with elliptical or eccentric bearings. An important feature of this analysis is relatively low computing cost. The analysis is followed by an illustrative example in which 17 different cases of a connecting-rod bearing are solved.

85-708
Vibration of a Hydrostatic Gas Bearing Due to Supply Pressure Oscillations
H.D. Branch, C.B. Watkins, I.E. Eronini
NASA Goddard Space Flight Ctr., Greenbelt, MD 20771
Wear, 95 (2), pp 199-212 (1984) 4 figs, 4 tables, 6 refs

KEY WORDS: Journal bearings, Gas bearings, Torsional vibrations, Radial vibrations

The vibration of a statically loaded, inherently compensated hydrostatic journal bearing due to oscillating supply pressure is investigated. Both angular and radial vibration modes are analyzed. The time-dependent Reynolds equation governing the pressure distribution between the oscillating journal and the sleeve is solved numerically together with the journal equation of motion to obtain the response characteristics of the bearing. The results presented include Bode plots of bearing oscillation gain and phase for a particular bearing configuration for various combinations of parameters over a range of frequencies. The results are compared with the results of an earlier study involving the response of a similar bearing to oscillating exhaust pressure.

85-709
Performance Characteristics of Elliptical Journal Bearings in Turbulent Flow Regime
H. Hashimoto, S. Wada, H. Tsunoda
Tokai Univ., Hiratsuka-shi-Kanagawa, Japan
Bull. JSME, 27 (232), pp 2265-2271 (Oct 1984) 9 figs, 1 table, 11 refs

KEY WORDS: Journal bearings, Turbulence

In this paper, the performance characteristics of elliptical journal bearings in turbulent flow regime are studied theoretically and experimentally. By solving the turbulent lubrication equation by the semi-analytical finite element method, the static and dynamic characteristics are obtained. Various mean Reynolds' numbers and ellipticity ratios are considered and the results are compared with the experimental ones. It is found that the turbulence affects the static and dynamic characteristics of such bearings and the stability limits of the

bearings become larger with an increase of ellipticity ratio.

85-710
Boundary Conditions for the Calculation of the Dynamic Characteristics of Infinitely Long Journal Bearings with Turbulence and Inertia Effects
H. Hashimoto
Tokai Univ., Kanagawa, Japan
Wear, 96 (1), pp 1-16 (June 1, 1984) 7 figs, 15 refs

KEY WORDS: Journal bearings, Turbulence, Inertial forces, Boundary condition effects

A discussion is presented concerning the various pressure boundary conditions used in the calculation of the dynamic characteristics of infinitely long journal bearings under turbulent operating conditions, including inertia effects. The dynamic characteristics of bearings -- the spring, damping and acceleration coefficients and the stability limit curves of a rigid rotor supported by two identical symmetrically aligned bearings are determined. Four kinds of pressure boundary conditions are considered. The calculated results for each condition are indicated in graphical form.

85-711
Periodic Ball Behavior in a Deep Groove Ball-Bearing under Conditions of Low Radial Load and Low Shaft Speed
K. Kawakita, S. Ariyoshi, F. Hirano
Kyushu Univ., Ropponmatsu, Chuo-Ku, Fukuoka-Shi 810, Japan
Wear, 95 (1), pp 9-17 (Apr 2, 1984) 8 figs, 10 refs

KEY WORDS: Ball bearings, Balls, Periodic response

The actual ball behavior during one cage revolution was investigated by using a new measuring method for three-dimensional ball motion. From the experimental results, periodic ball motion with slip was recognized.

85-712
Bearing Protects Against Unbalance
M.L. Adams, T.H. McCloskey, E. Makay
Case Western Reserve Univ., Cleveland, OH 44106
Power, 128 (9), pp 111-112 (Sept 1984) 3 figs, 5 refs

KEY WORDS: Tilt pad bearings, Unbalanced mass response, Turbines

Large rotor unbalance, caused by loss of blading, for example, can unleash a potentially devastating nonlinear dynamic phenomenon in a steam turbine/generator known as subharmonic resonance. Results of this work are summarized. They show a phenomenon that probably is typical of all units operating only marginally below an oil-whip (self-excited vibration) threshold speed. That phenomenon is the sudden, drastic increase in vibration levels, on units with fixed-arc bearing.

GEARS

85-713
Bending Fatigue Strength of Spur Gears in Low-Cycle Range
S. Oda, K. Miyachika, Y. Harada
Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan
Bull. JSME, 27 (233), pp 2538-2544 (Nov 1984) 16 figs, 5 refs

KEY WORDS: Spur gears, Fatigue life

This paper presents a study on bending fatigue strength of spur gears in low-cycle range. Calculating methods for adjacent-tooth gaps and the circumferential load, under which adjacent-tooth contacts occur due to the deflections of meshing teeth, are introduced. The validity of these calculating methods is confirmed by carrying out a static loading test. The characteristics of the bending fatigue strength of spur gears in low-cycle range are clarified.

85-714
Effects of Key on Bending Fatigue Breakage of Thin-Rimmed Spur Gears
S. Oda, K. Miyachika
Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan
Bull. JSME, 27 (232), pp 2279-2286 (Oct 1984) 13 figs, 6 refs

KEY WORDS: Spur gears, Keys, Fatigue life, Finite element technique

This paper presents a study on the effects of key on bending fatigue breakage of a thin-rimmed spur gear. A stress analysis by means of the two-dimensional finite element method and a bending fatigue test were carried out. The effects of rim thickness and the position of keyway on the root stresses, the stresses of keyway, and the position of the fatigue crack initiation were investigated.

85-715
Effects of Addendum Modification on Bending Fatigue Strength of Helical Gears
S. Oda, T. Koide
Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan
Bull. JSME, 27 (232), pp 2272-2278 (Oct 1984) 13 figs, 1 table, 16 refs

KEY WORDS: Helical gears, Fatigue life

This paper presents a study on the effects of addendum modification on root stresses and bending fatigue strength of helical gears. A theoretical analysis was made on the effect of addendum modification on the root stresses. Bending fatigue tests were performed on helical gears with various amounts of addendum modification, using a bending fatigue testing machine of hydraulic type.

FASTENERS

85-716
Transmission of Waves through Localized Discontinuities; Evaluation of Two Approaches
G. Maidanik, L.J. Maga
David Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD 20084
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, p 83 (Abstract only)

KEY WORDS: Joints, Sound waves, Wave transmission

Two approaches are discussed for describing the transmission of waves through coupling junctions. A coupling junction specifies the coupling between two adjacent dynamic systems. The transmission between dynamic systems that are singly, doubly, and triply removed from each other are cited as examples.

SEALS

85-717
Analysis for Leakage and Rotordynamic Coefficients of Surface-Roughened Tapered Annular Gas Seals
C.C. Nelson
Texas A&M Univ., College Station, TX 77843
J. Engrg. Gas Turbines Power, Trans. ASME, 106 (4), pp 927-934 (Oct 1984) 6 figs, 1 table, 10 refs

KEY WORDS: Seals, Surface roughness

This analysis develops an analytical computational method to solve for the rotordynamic coefficients of a deliberately roughened stator and smooth rotor combination of compressible-flow seal. An example case is used to demonstrate the effect of changing from a smooth to a rough stator while varying the seal length, taper, preswirl, and clearance ratio.

85-718
Prediction of Stiffness and Damping Coef-

ficients for Centrifugal Compressor Labyrinth Seals
H.R. Wyssmann, T.C. Pham, R.J. Jenny
Sulzer-Escher Wyss, Ltd., Zurich, Switzerland
J. Engrg. Gas Turbines Power, Trans. ASME, 106 (4), pp 920-926 (Oct 1984) 15 figs, 17 refs

KEY WORDS: Seals, Stiffness coefficients, Damping coefficients, Centrifugal compressors

A theory is presented for the calculation of stiffness and damping coefficients of the fluid-rotor interaction in centrifugal compressor labyrinth seals based on turbulent flow calculations. The theory has been confirmed by measurements on labyrinth test stands and on a centrifugal compressor impeller shroud seal at pressures up to 140 bar. Predicted rotor stability limits based on the theory are in agreement with those observed in real compressors.

85-719
Computational Fluid Mechanics Utilizing the Variational Principle of Modeling Damping Seals
Continuum, Inc., Huntsville, AL
Rept. No. NASA-CR-171114, 3 pp (Mar 31, 1984) N84-31553

KEY WORDS: Seals, Damping, Spacecraft

The pressure solution for incompressible flow was investigated in support of a computational fluid mechanics model. It simulates the damping seals considered for use in the space shuttle main engine turbomachinery.

STRUCTURAL COMPONENTS

BARS AND RODS

85-720
On a Nonlocal Theory of Longitudinal Waves in an Elastic Circular Bar
J.L. Nowinski
Univ. of Delaware, Newark, DE 19711
Acta Mech., 52 pp 189-200 (1984), 1 fig, 25 refs

KEY WORDS: Circular bars, Longitudinal waves, Fourier transformation

The values of the nonlocal moduli for longitudinal waves in an infinite space are determined. Fourier transforms of the equations of axially symmetric longitudinal waves in an infinite circularly cylindrical rod are established and decoupled. Dispersion equation is obtained from the conditions of traction free surface of the rod, and compared with its classical counterpart.

85-721
Dynamic Analysis of Systems of Bars Encased in Elastic Medium
S.M. Aljaweini, J.J. Tuma
Dept. of Civil Engrg., Arizona State Univ., Tempe, AZ
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 73-82, 1 fig, 4 tables, 3 refs

KEY WORDS: Bars, Harmonic excitation, Elastic media

A general method is presented for the analysis of space frames encased fully or partially in elastic medium and subjected to time-dependent loads of harmonic variation. These loads arise from rotating or reciprocating machinery. Offshore structures, pipelines, bridges, components of ships and aerospace structures are examples of such systems. The analysis is restricted to systems of straight linearly elastic bars of constant sections, which have two orthogonal axes of symmetry or are axial symmetrical. The time-independent mass of each bar is uniformly distributed along its axis. The material constant of each bar and of its surrounding medium are independent of time and are known from experiments. The sign convention of

the transport method and of the stiffness method is used in the respective sections.

85-722
Inverse Problems for the Vibrating Rod and Beam
J.A. Gbadeyan
Ph.D. Thesis, Univ. of Waterloo, Canada (1984)

KEY WORDS: Rods, Beams

This thesis concerns inverse vibration problems for rods and beams. The problem of determining the structural elements of a rod or a beam from a knowledge of certain frequency spectral data is addressed.

BEAMS

85-723
Comparisons Based on an Energy Ratio of Accuracy and Frequency Content in an Euler and Timoshenko Beam Finite Element
L.J. Everett
Texas A&M Univ., College Station, TX 77843
ASME Paper No. 84-DET-47

KEY WORDS: Finite element technique, Timoshenko theory, Euler beams

This paper compares the performance of two beam type finite elements for use in time response calculations of compliant mechanisms. An Euler stiffness element is compared to an isoparametric, Timoshenko type.

85-724
Estimation of Vibratory Input to Mechanical Structure
K. Yoshida
Keio Univ., 3-14-1 Hiyoshi, Kohoku-ku, Yokohama, 223, Japan
Bull. JSME, 27 (232), pp 2226-2232 (Oct 1984) 9 figs, 15 refs

KEY WORDS: Beams, Vibration excitation

An estimation method of the fluctuation and position of a vibratory input to a mechanical structure is presented. First, the condition of the invertibility and the stability of an inverse system are made clear. Second, the models of a two-degree-of-freedom system and a rigid bar supported elastically are used to demonstrate that the inverse system can be constructed by applying the inverse system theory.

85-725
A New Beam Finite Element with Seven Degrees of Freedom at Each Node for the Study of Coupled Bending-Torsion Vibrations
A. Potiron, D. Gay, C. Czekajski
National Inst. of Applied Sciences
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 109-117, 1 fig, 1 table, 6 refs

KEY WORDS: Beams, Finite element techniques, Warping, Bending-torsion

The subject matter of the first part of this study is the derivation of coupled bending-torsion relations characterizing the dynamical behavior of unsymmetrical cross-section beams. This allows for the further definition of a beam element with seven degrees of freedom per node. The numerical results obtained with the finite element method are compared to experiment in some section shape cases.

85-726
A Boundary Element Program for the Calculation of Coupled Flexure Torsion Constants for Beams of any Cross Section Shape

C. Czekajski, D. Gay, A. Potiron
National School of Aeronautics and Space
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 119-125, 2 figs, 1 table, 6 refs

KEY WORDS: Beams, Boundary element technique, Flexural vibration, Torsional vibration

The main feature of the presented work consists of the introduction of auxiliary functions allowing the conversion of surface integrals into boundary integral expressions. Accuracy of computed results has been tested on several symmetric as well as asymmetric section shapes.

85-727
Amplitude Growth in Vibrations of Arms with Increasing Length
S. Bergamaschi, A. Sinopoli, A. Repaci
Inst. of Applied Mechanics, Univ. of Padua, Italy
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 36-45, 4 figs, 6 refs

KEY WORDS: Beams, Flexural vibrations, Timoshenko theory, Perturbation theory

The Timoshenko theory of flexural vibrations of beams and a perturbation (the WKB) method are adopted to evaluate the amplitude changes of the free vibrations of beams. The length of the beams varies linearly with time. It is found that the change is dependent only on the length increase (or decrease). Results are also given for the frequency modifications.

85-728
Accurate Nonlinear Equations and a Perturbation Solution for the Free Nonplanar Vibrations of Inextensional Beams
A. Luongo, G. Rega, F. Vestroni
Istituto di Scienza delle Costruzioni, Univ. of Rome, Italy
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 341-350, 9 refs

KEY WORDS: Beams

In the present work free nonplanar motions of an inextensional elastic beam with no warping and shear deformation, supported in an arbitrary manner but not axially restrained, are studied.

85-729
A Finite Element Method for Nonlinear Forced Vibrations of Beams
C. Mei, K. Decha-Umphai
Dept. of Mech. Engrg. and Mechanics, Old Dominion Univ., Norfolk, VA
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 319-328, 3 figs, 2 tables, 13 refs

KEY WORDS: Beams, Finite element technique, Harmonic excitation

The finite element method has been extended to analyze nonlinear forced vibration problems. A harmonic force matrix was developed for a beam element subjected to uniform harmonic excitation. Improved finite element results on nonlinear free flexural vibration of slender beams are achieved.

85-730
Snap-through of Initially Buckled Beams under Uniform Random Pressure
P. Seide
Dept. of Civil Engrg., Univ. of Southern California
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984,

Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 329-340, 6 figs, 1 table, 9 refs

KEY WORDS: Beams, Initial deformation effects, Random excitation, Snap through problems

The present investigation serves to cast some light on the behavior of initially buckled beams under random loading. A reasonable indication of the critical spectral density of loading required for beam snap-through appears to be the vanishing of the average zero-crossing frequency of the beam.

85-731
Non-Stationary Division by the Space Time Finite Element Method in Vibration Analysis
C.I. Bajer
Engrg. College, Zielona Gora, Poland
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 161-169, 11 figs, 4 refs

KEY WORDS: Beams, Stiffness methods

Main principles of the space-time finite element method for the analysis of beam vibrations are presented. The discussion involves the derivation of stiffness, mass and damping matrices, stability and accuracy analysis. In addition the solution for selected test problems are described.

85-732
Review of Air-Blast Response of Beams and Plates
J. Ari-Gur, D.L. Anderson, M.D. Olson
Armament Development Authority, Israel
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 383-392, 8 figs, 21 refs

KEY WORDS: Beams, Plates, Air blast

The objective of the present study is to provide a comprehensive review of the behavior of beams and plates which are subjected to air blast loadings. Since this is a compilation and analysis of published research results, it will also serve as a guide to the needs for future research.

85-733
The Effect of Small Clearances and Friction-Loaded Constraint Points on Bending Wave Energy Transmission in a Long Beam
M.J.H. Fox
CEGB, Berkeley Nuclear Labs.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 373-382, 6 figs, 8 refs

KEY WORDS: Beams, Flexural waves, Energy transmission, Constrained structures

This paper considers the effect on bending wave energy transmission in an infinite beam of constraints in the form of nonlinear force/displacement or force/velocity relationships. A point receptance method is used. The linear (Euler beam theory) equations for the beam in the absence of the constraints are used to derive explicit expressions for displacement or velocity at the points where constraints are to be applied. Substitution of the chosen forms of these forces then lead to (nonlinear) integral equations determining displacement or velocity at the constraint points. In this way the infinite number of degrees of freedom of the original problem have been reduced to a number equal only to the number of nonlinear constraints, for numerical solution.

85-734
Some Closed-Form Solutions in Random Vibration of Timoshenko Beams

I. Elishakoff, D. Livshits
Technion - Israel Inst. of Tech., Haifa, Israel
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 639-648, 4 tables, 10 refs

KEY WORDS: Beams, Timoshenko theory, Random vibrations

Random vibration of simply supported uniform Timoshenko beams is considered under stationary space and time wise ideal white noise excitation. The main finding of this study is identity of the space-time correlation functions of displacement according to the refined Timoshenko theory and the classical Bernoulli-Euler theory. Joint ...ion of rotary inertia and shear deforma... ...neglected.

85-735
Wave Propagation in Circularly Curved Beams and Rings
O.A. Fettahlioglu, G.M. Yehodian
New York Inst. of Technology
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 3-13, 6 figs, 3 tables, 14 refs

KEY WORDS: Curved beams, Rings, Wave propagation

Hamilton's principle is used to derive the exact equations of motion for thin circularly curved beams and rings. The effects of distributed elastic foundations in the directions of the radial and tangential displacements and the rotation are also incorporated into the equations of motion.

85-736
Multiobjective Optimization in Structural Design with Uncertain Parameters and Stochastic Processes
S.S. Rao
San Diego State Univ., San Diego, CA
AIAA J., 22 (11), pp 1670-1678 (Nov 1984) 1 fig, 6 tables, 20 refs

KEY WORDS: Cantilever beams, Base excitation, Stochastic processes, Optimum design

The application of optimization techniques to the design of a cantilever beam with a tip mass subjected to a stochastic base excitation is considered. The solution is found by using global criterion, utility function, game theory, goal programming, goal attainment, bounded objective function, and lexicographic methods. The game theory approach is superior.

85-737
Damped Vibrations of a Jointed Cantilever Beam
H. Wissbrok
Institut f. Mechanik, Universität Hannover, Hannover, W. Germany
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 361-372, 14 figs, 4 refs

KEY WORDS: Cantilever beams, Joints, Damping

The application of methods to increase damping to machine tool frames has disadvantages. For example, the optimization of frictional damping requires a nonacceptable loss of stiffness. This paper is concerned with avoiding this stiffness loss by using frictional interfaces formed by fastening beam-like elements on the vibrating frame. Such frictional ledges can be fixed with an interface pressure for maximal damping without any reduction of machine stiffness.

85-738
Complex Frequency Analysis of Damped Thin-Walled Beams with Open Cross Sections

M.F. Ahmad
Ph.D. Thesis, Univ. of New Hampshire, 345 pp (1984) DA8419548

KEY WORDS: Beams, Shells, Frequency analysis, Computer programs

The dynamic equilibrium equations for thin-walled beams of open cross section are derived with reference to an arbitrary system of coordinates. Structural damping is introduced through complex moduli. Direct dynamic stiffness is used as a base for a numerical solution of the complex frequency response problem. A computer program is used in both free and forced response of thin-walled beams. The study indicated the effect of the damping coefficient on response.

COLUMNS

85-739
Nonlinear Behavior of Thin Columns under a Parametrically Excited Load
M. Sunakawa, K. Higuchi
Univ. of Tokyo, Tokyo, Japan
AIAA J., 22 (12), pp 1791-1796 (Dec 1984) 13 figs, 3 tables, 14 refs

KEY WORDS: Columns, Parametric excitation

Variation of response amplitude is related in closed form to the phase difference between excitation and response; behavior of the column is examined in detail. Initial disturbances have little effect on the nonlinear response. Response under comparatively large excitation is presented. Parametrically unstable phenomena can be evaluated using a relatively simple nonlinear equation and the present theoretical results.

MEMBRANES, FILMS, AND WEBS

85-740
A Simple Approximate Method for the Solution of the Helmholtz Equation in the Case of Rectangular, Non-homogeneous Domains
P.A.A. Laura, R.H. Gutierrez
Inst. of Appl. Mechanics, 8111-Puerto Belgrano Naval Base, Argentina
Appl. Acoust., 17 (6), pp 405-411 (1984) 3 figs, 2 tables, 4 refs

KEY WORDS: Rectangular membranes, Variable material properties, Ritz method

Discontinuous types of nonhomogeneities are considered in this paper. It is shown that the Ritz method is convenient for this complex structural element.

PANELS

85-741
Sonic Fatigue Design Method for the Response of CFRP Stiffened-Skin Panels
I. Holehouse
Rohr Industries, CA
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 787-798, 8 figs, 7 refs

KEY WORDS: Panels, Fiber composites, Acoustic fatigue, Design techniques

This paper describes the development of a semi-empirical method to estimate the structural response of carbon-fiber reinforced plastic (cfrp) stiffened-skin panels when subjected to random acoustic loading. The objective was to provide a method suitable for practical use in the design of cfrp airplane structures.

PLATES

85-742
Nonlinear Analysis of Plate and Shell Vibrations

A.W. Leissa
Ohio State Univ., Columbus, OH
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 241-260, 3 figs, 2 tables, 77 refs

KEY WORDS: Plates, Shells, Nonlinear theories

The present paper presents an overview of the subject of nonlinear vibrations of plates and shells and summarizes recent literature on the subject. The publications referenced have appeared in the past five years with the exception of a few background references. The present work is restricted to free, undamped vibrations.

85-743

Application of the Method of Integral Equations to the Vibration of Plates

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Institut f. Technische Akustik, Technische Universität Berlin
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 171-177, 1 fig, 8 refs

KEY WORDS: Plates, Boundary value problems, Integration methods, Flexural vibration

An integral representation of boundary value problems for the evaluation of flexural vibration of thin plates with arbitrary shape for all kinds of excitation is presented. The special case of vanishing excitations can be used to determine natural frequencies and associated modes for a given plate arrangement. A combination of integral relations for adjacent areas and a system of integro-differential equations allows solution of problems with regions of constant but different parameters.

85-744

Large Amplitude Vibrations of Initially Stressed Bimodulus Thick Plates

Lien-Wen Chen, C.J. Lin
National Cheng Kung Univ., Tainan, Taiwan, Rep. of China
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 567-576, 7 figs, 13 refs

KEY WORDS: Plates, Galerkin method

Nonlinear governing differential equations of an initially stressed bimodulus thick plates are presented. The Galerkin approximate method and the Runge-Kutta method are used. Results are compared with previous results for ordinary thick plates and with results of bimodulus plates in small amplitude regions. Effects of various parameters on the large amplitude vibrations of bimodulus thick plates are studied.

85-745

Elastic Buckling and Flexural Vibration of Annular Plates under Axisymmetric In-Plane Forces

O. Majima, K. Hayashi
Sophia Univ., Kioi-Cho 7, Chiyoda-Ku, Tokyo, Japan
Bull. JSME, 27 (232), pp 2088-2094 (Oct 1984), 8 figs, 17 refs

KEY WORDS: Annular plates, Flexural vibration, Galerkin method

The problems have been analyzed by the Galerkin method using various combinations of boundary conditions at the outer and inner edges. Two cases are analyzed as examples of axisymmetric in-plane force distributions. The relations of buckling load parameter and hole size of natural frequency parameters and magnitude of the in-plane force are evaluated. Buckling is possible with force or cooling when the distributed in-plane stress has compressive components.

85-746
Vibration of Plates Elastically Supported on a Non-Homogeneous Foundation
P.A.A. Laura, R.H. Gutierrez
Inst. of Applied Mechanics, Puerto Belgrano Naval Base, 8111 - Argentina
J. Sound Vib., 95 (4), pp 531-536 (Aug 22, 1984), 4 tables, 3 refs

KEY WORDS: Circular plates, Elastic supports, Natural frequencies, Ritz method

This study deals with the determination of the fundamental of vibration of circular and regular polygonal plates elastically supported over a nonhomogeneous foundation. Both cases are tackled in a unified fashion by adopting polynomial coordinate functions and making use of the Ritz method to obtain the frequency equation.

85-747
Non-Stationary Responses of Non-Linear Rectangular Plates During Transition Through Parametric Resonances, Part 1: Theory
G.L. Ostiguy, R.M. Evan-Iwanowski
Ecole Polytechnique, Montreal, Canada
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 535-546, 7 figs, 9 refs

KEY WORDS: Rectangular plates, Parametric resonance, Periodic excitation

The present work deals with nonstationary parametric responses of a nonlinear rectangular plate simply supported along its edges and subjected to the action of periodic in-plane forces uniformly distributed along two opposite edges. The non-stationary response of the plate during a logarithmic sweep of the excitation frequency through a system resonance is evaluated for a variety of cases. The validity of these results is ascertained experimentally.

85-748
Non-Stationary Responses of Non-Linear Rectangular Plates During Transition Through Parametric Resonances, Part 2: Experiment
G.L. Ostiguy, R.M. Evan-Iwanowski
Ecole Polytechnique, Montreal, Canada
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 547-557, 12 figs, 5 refs

KEY WORDS: Rectangular plates, Parametric resonance, Periodic excitation, Test data

An experimental study of the nonstationary parametric response of simply-supported nonlinear rectangular plates was performed. Special attention was paid to satisfy the boundary conditions assumed in the analytical model so that conclusions would be reasonably valid. Experimental data are compared with analytical predictions to form a qualitative and quantitative verification of the solution.

85-749
Nonlinear Dynamic Analysis of Anisotropic Rectangular Plates by a New Method
M. Sathyamoorthy
Clarkson College of Technology, Potsdam, NY 13676
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol.II, pp 559-566, 6 tables, 16 refs

KEY WORDS: Rectangular plates, Anisotropy, Nonlinear theories, Self-generating functions

This paper is concerned with the nonlinear static as well as dynamic analysis of anisotropic plates of rectangular and square geometries. The nonlinearities arise due to large deformation or large amplitude vibration and are included in the nonlinear strain-displacement relations. New functions called self-generating functions are used to obtain linear and nonlinear frequencies in

dynamic problems and load-deflection behavior in static problems.

85-750
Non-Linear Multimode Response of Clamped Rectangular Plates to Acoustic Loading
Chuh Mei, D.B. Paul
Old Dominion Univ.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 577-587, 6 figs, 1 table, 11 refs

KEY WORDS: Rectangular plates, Acoustic excitation, Fatigue life

This paper presents an analytical solution technique for the large-amplitude random response of clamped rectangular plates considering multiple modes in the analysis. Von Karman large-deflection plate equations are solved. A Fourier-type series representation of out-of-plane deflection and stress function is assumed. The compatibility equation is solved by direct substitution, and the equilibrium equation is solved by the Bubnov-Galerkin approach. The acoustic excitation is assumed to be Gaussian. The Krylov-Bogoliubov-Caughey equivalent linearization method is used.

85-751
Vibrations of Rectangular Plates with Elastically Restrained Edges
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Univ. of Nottingham, Nottingham NG7 2RD, UK
J. Sound Vib., 95 (4), pp 537-552 (Aug 22, 1984) 9 figs, 2 tables, 19 refs

KEY WORDS: Rectangular plates, Elastic restraints, Natural frequencies, Rayleigh-Ritz method

The Rayleigh-Ritz method is used to determine natural frequencies in transverse vibration of rectangular plates with elastically restrained edges. The accuracy of the method is demonstrated by solving test problems. The method can be applied to a wide range of elastic restraint conditions, any aspect ratio, and for higher modes. The effect of in-plane forces on natural frequencies and the determination of critical loads for plates with these restraint conditions are considered.

SHELLS

85-752
Asymmetric Vibrations of Thick Shells of Revolution
T. Kosawada, K. Suzuki, S. Takahashi
Yamagata Univ., 4-3-16 Jyonan, Yonezawa, Yamagata, Japan
Bull. JSME, 27 (233), pp 2492-2499 (Nov 1984) 9 figs, 17 refs

KEY WORDS: Shells of revolution, Asymmetric vibrations, Natural frequencies, Mode shapes

Asymmetric vibrations of barrel-like shells of revolution are analyzed using an improved thick shell theory. The equations of motion and the boundary conditions are determined from the stationary conditions of the Lagrangian of the shells of revolution. The equations of motion are solved analytically by a series solution. Effects of various parameters upon natural frequencies are clarified through analysis of numerical results. The results are compared with those of classical thin shell theory. Effects of rotatory inertia and shear deformation upon natural frequencies are clarified.

85-753
Nonlinear Forced Oscillations of a Shallow Spherical Shell
K. Yasuda, G. Kushida
Nagoya Univ., Chikusaku, Nagoya, Japan
Bull. JSME, 27 (232), pp 2233-2240 (Oct 1984) 10 figs, 9 refs

KEY WORDS: Spherical shells, Harmonic excitation

Axisymmetric forced oscillations of a shallow spherical shell subjected to harmonic excitation are investigated. A theoretical analysis is conducted of the harmonic oscillation as well as the subharmonic oscillation of order 1/2. In certain cases the response curve of the harmonic oscillation is a soft spring type, subharmonic oscillation of order 1/2 can occur, and subharmonic oscillation is greatly influenced by internal resonance. An experimental analysis using a shallow spherical steel shell confirms the validity of the theoretical analysis.

85-754

Axisymmetric Static and Dynamic Buckling of Orthotropic Shallow Spherical Caps with Flexible Supports

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Indian Inst. of Tech., New Delhi 110016, India

Acta Mech., 52, pp 93-106 (1984) 7 figs, 24 refs

KEY WORDS: Spherical shells, Elastic supports, *Dynamic buckling*, *Orthotropism*

This investigation deals with the static and dynamic axisymmetric buckling of elastic orthotropic thin shallow spherical shells with elastically restrained edge for inplane and rotational displacements. Governing equations in terms of normal displacement and stress function are employed. Orthogonal point collocation method is used for spatial discretization; Newmark-beta scheme is used for time-marching. Uniformly distributed static and step function conservative loadings normal to the undeformed surface are considered. Results are in good agreement with available results. The influence of orthotropicity parameter and support stiffness parameters on the static and dynamic buckling loads is investigated.

85-755

Resonant Frequencies and Mode Shapes for Single and Double Cylindrical Shells

C.B. Burroughs, S.I. Hayek, D.A. Bostian, J.E. Hallander
Applied Res. Lab., Pennsylvania State Univ., State College, PA

Rept. No. TM-83-169, 102 pp (Sept 23, 1983) AD-A144 778

KEY WORDS: Cylindrical shells, Concentric shells, Natural frequencies, Mode shapes

Resonant frequencies and mode shapes for single and double cylindrical shells are identified from measurements made with the shells in air and in water. Resonant frequencies are reported for frequencies up to 1000 Hz. The first eight resonant bending modes are identified. Submerging the shell assembly reduces resonant frequencies of the lowest bending modes to nearly one half the frequencies for the shell assembly in air.

85-756

Calculation of Natural Frequencies of Specially Orthotropic Multilayered Thin Circular Cylinders

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Inst. of Science and Tech., Univ. of Manchester, Manchester M60 1QD, UK

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 15-24, 12 figs, 14 refs

KEY WORDS: Cylindrical shells, Layered materials, Orthotropism, Natural frequencies

A simple theoretical analysis for determining natural frequencies of thin-walled circular cylindrical shells with layers of homogeneous isotropic or specially orthotropic material symmetrically situated about the shell mid-surface are presented. Various end conditions are studied. The theory governing the response is based on the Love-Timoshenko hypothesis of deformation. It is capable of handling a shell structure comprised of an arbitrary number of thin bonded layers with different thicknesses and elastic material properties.

85-757

Dynamic Response of Layered Orthotropic Cylindrical Shells Subjected to Pressure and Axial Loadings

O.A. Fettahlioglu, A.M. Sayed
New York Inst. of Technology

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 25-35, 8 figs, 4 tables, 14 refs

KEY WORDS: Cylindrical shells, Layered materials, Transverse shear deformation effects, Rotatory inertia effects

This paper presents a study of the dynamic response of layered orthotropic cylindrical shells subjected to uniform pressure and/or axial loading, accounting for the influence of the change in the meridional slope (the so-called pressurization effect), transverse shear deformation, and rotatory inertia.

85-758

Some Recent Advances in Dynamic Response of Shells

R.K. Kapania, T.Y. Yang
Purdue Univ., West Lafayette, IN

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 199-208, 5 figs, 14 refs

KEY WORDS: Shells of revolution

Deterministic and nondeterministic response analyses of shells of revolution were studied using a 48 degree of freedom quadrilateral shell element. For the deterministic analysis, both modal superposition and direct integration methods were used. For the random response analysis, a Gaussian integration scheme was used to calculate the matrix of the cross spectral densities of the generalized nodal forces. The analysis is applied to the probabilistic response of a cooling tower subjected to wind loads and can be extended to the probabilistic response of thin shells.

PIPES AND TUBES

85-759

A Two-Dimensional Model for Fluid-Structure Interaction in Curved Pipes

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Nucl. Engrg. Des., 80 (1), pp 1-10 (July 1, 1984) 7 figs, 19 refs

KEY WORDS: Curved pipes, Fluid-structure interaction

A channel model was developed to simulate the interactive fluid-structural response of curved pipes to pressure pulses. Simulation was achieved analytically in both the axisymmetric and transverse modes. An experimental program aimed at validation of the model is described. Tests were run in both straight and curved pipe configurations. Comparisons between measurements and model calculations demonstrate the validity of the model within the range of parameters under consideration. The model was implemented into the DISCO code for nonlinear fluid-shell interaction.

85-760

Seismic Stress Fields for Nuclear Elbows Using Toroidal Elasticity Theory

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LANG-Research West, Santa Monica, CA

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 47-54, 1 fig, 1 table, 4 refs

KEY WORDS: Curved pipes, Seismic response, Elasticity theory

The methods of toroidal elasticity are extended to determining the stress fields in a hollow circular elbow or pipe bend under the action of seismic accelerations. The seismic accelerations are represented by equivalent body forces acting in arbitrary

directions. The seismic forces can also be viewed as upper bounds obtained from seismic response curves. Calculations are made for parameters corresponding to major elbows of nuclear plants.

The most commonly used structural elements in engineering are sometimes designed to withstand sudden dynamic loads. Some structures are subjected to dynamic overloads by accident. This situation is of concern to the design and safety engineer. The behavior of framed structures under impulsive load is the subject of this paper.

BUILDING COMPONENTS

85-761

Random Vibration of Discrete, Periodic Coupled Frame-Wall Systems

G. Oliveto, A. Santini

Istituto di Scienza delle Costruzioni Universita di Catania

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 649-663, 14 figs, 2 tables, 15 refs

KEY WORDS: Framed structures, Walls, Random vibration, Seismic response

This paper considers the response of coupled frame-wall systems to earthquake motions. With minor alterations the procedure can also be applied to wind excitations.

85-762

Elastic-Plastic Response of Rooftop Frames to Distributed and Concentrated Shock Load: Experimental Results and Theoretical Predictions

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"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 609-620, 11 figs, 23 refs

KEY WORDS: Framed structures, Roofs, Shock response, Elastic plastic properties

85-763

New Floor Response Spectrum Method for Seismic Analysis of Multiply Supported Secondary Systems

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Earthquake Engrg. Res. Ctr., Univ. of California, Richmond, CA

Rept. No. UCB/EERC-84/04, NSF/CEE-84019, 122 pp (June 1984) PB84-239417

KEY WORDS: Floors, Seismic response spectra

The method defines an extension of the conventional floor response spectrum denoted cross-oscillator, cross-floor response spectrum (CCFS). The CCFS is proportional to the covariance of the response of two fictitious oscillators subjected to the motions of the primary system at two support points. Through this concept, important effects not accounted for in current floor-spectrum methods are included in the analysis.

85-764

Response of a Plaster-Wood Room Subjected to Simulated Sonic Booms

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Rept. No. UTIAS-276, 402 pp (July 1984) N84-31701

KEY WORDS: Rooms, Sonic boom

Pressure variations inside the room were predicted analytically by viewing the room as a Helmholtz resonator. Measured strains in the vicinity of a crack-tip are in agreement with predicted values. For a plaster-wood wall a crack will propagate if

the overpressure of an incident sonic boom exceeds 265 N/sq m. For an N-wave with an overpressure of 100 N/sq m, crack propagation can occur if crack length is larger than 0.7 the wall width.

ELECTRIC COMPONENTS

MOTORS

85-765
Natural Frequencies of Stator Core of Induction Motor (1st Report, Characteristics of Radial Vibration)
M. Shiga
Hitachi Ltd., Kandatsu, Tsuchiura, Ibaraki, Japan
Bull. JSME, 27 (233), pp 2500-2505 (Nov 1984) 8 figs, 1 table, 6 refs

KEY WORDS: Stators, Radial vibrations, Natural frequencies, Induction motors

Two natural frequencies have the same deformation wave numbers. The relation between these and the natural frequencies is represented by two curves with two asymptotes; one shows the characteristics of the natural frequencies of the ring, and the other shows the characteristics of the teeth. The lower frequency can be calculated precisely by Dunkerley's formula. Experimental results are in good agreement with theoretical results based on a two-degree-of-freedom system.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

85-766
Influence of Horizontal Random Structure on Acoustic Intensity in a Shallow Ocean
C.E. Ashley, M.J. Jacobson, W.L. Siegmann
Rensselaer Polytechnic Inst., Troy, NY 12180
J. Acoust. Soc. Amer., 76 (5), pp 1445-1455 (Nov 1984) 9 figs, 16 refs

KEY WORDS: Underwater sound, Oceans

Effects of random bottom structure on acoustic intensity in isospeed shallow water are studied. Expressions obtained are sufficiently general to permit their use with different bottom-acoustic models of sound reflection. Two such models are considered. The acoustic consequences of bottoms of different density mean, variance, and horizontal correlation are discussed, as are comparisons of results for the two bottom-reflection models. Intensity moments are obtained for various source-receiver ranges and water depths.

85-767
The Probability Distribution of Intensity for Acoustic Propagation in a Randomly Varying Ocean
C. Macaskill, T.E. Ewart
Univ. of Cambridge, Silver Street, Cambridge CB3 9EW, UK
J. Acoust. Soc. Amer., 76 (5), pp 1466-1473 (Nov 1984) 7 figs, 16 refs

KEY WORDS: Underwater sound, Sound waves, Wave propagation

Probability distributions of intensity fluctuations from the MATE, AFAR, and S.W. Bermuda underwater acoustics experiments are compared with recently derived theoretical expressions. The limitations and strengths of these expressions are discussed. One description is modified for the moments of intensity that reduce analytically to the log-normal distribution at short range and to the exponential distribution at long range. This form also predicts higher moments. It is expected that the new expression will be applicable at all ranges.

85-768
Minimum Target Size in Radiation Force Measurements

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Physikalisch-Technische Bundesanstalt, Braunschweig, W. Germany
J. Acoust. Soc. Amer., 76 (5), pp 1505-1510 (Nov 1984), 3 figs, 18 refs

KEY WORDS: Sound waves, Wave radiation, Force measurement

This paper uses recent progress in the theoretical treatment of the radiation force of three-dimensional sound fields. An assessment formula involves the radius and distance of a target from a source. The formula is valid for the field of a baffled, circular, continuously vibrating piston source.

85-769
Calculation of Acoustic Wave Scattering by Means of the Helmholtz Integral Equation. II
W. Tobocman
Case Western Reserve Univ., University Circle, Cleveland, OH 44106
J. Acoust. Soc. Amer., 76 (5), pp 1549-1554 (Nov 1984), 4 figs, 2 tables, 4 refs

KEY WORDS: Sound waves, Wave scattering, Helmholtz integral method

This paper presents results of test calculations employing the Helmholtz integral equation method to calculate the scattering of acoustic waves by fluid spheroids. Two alternative formulations of the method are tested; both give satisfactory results for spherical targets. The rate of convergence of one method deteriorates rapidly with increasing nonsphericity; the rate of convergence of the other does not.

85-770
Mixed-Mode Acoustical Glory Scattering from a Large Elastic Sphere: Model and Experimental Verification
K.L. Williams, P.L. Marston
Washington State Univ., Pullman, WA 99164-2814
J. Acoust. Soc. Amer., 76 (5), pp 1555-1563 (Nov 1984), 5 figs, 1 table, 20 refs

KEY WORDS: Sound waves, Wave scattering

This paper completes a theory for the case of mixed-mode echoes in which there is at least one longitudinal (L) to shear (S) wave or S to L mode conversion due to reflection. The focal parameters are independent of permutations of the mode sequence; however, contributions to scattering depend on sequence. The model is tested by measuring the amplitudes of the two distinct mixed-mode echoes having the large signal-to-noise ratios for a glass sphere and ka. (about 457). The Appendix models the plane-surface reflection and transmission phase and magnitude factors used in the theory.

85-771
Transient Fields Radiated by Curved Surfaces — Application to Focusing
D. Guyomar, J. Powers
Naval Postgraduate School, Monterey, CA 93943
J. Acoust. Soc. Amer., 76 (5), pp 1564-1572 (Nov 1984), 18 figs, 18 refs

KEY WORDS: Sound waves, Wave radiation, Wave diffraction

A theoretical model is presented for computing the transient radiated field (potential or pressure) resulting from a curved surface having an arbitrary velocity distribution. The method is a generalization of angular spectrum theory. The technique leads to a systems theory interpretation of radiation and diffraction effects. General expressions for arbitrary surfaces are given; important simplifications occur for radially symmetric geometries. Numerical simulations for common focused waves are given using computationally efficient FFT algorithms.

85-772
An Inverse Source Problem for Elastic Waves
J.E. Michaels
Ph.D. Thesis, Cornell Univ., 159 pp (1984), DA8415405

KEY WORDS: Elastic waves, Point source excitation

This thesis considers a point source, which is a volume or area source that is small compared to the distance to a receiver and measured wavelengths. Presented is an inversion procedure for a separable point source acting at a known location in a plate. The inversion procedure is demonstrated for synthetic data calculated for assumed sources. It is anticipated that this inversion method can be applied for a point source in any medium with known Green's functions.

85-773

Modeling the Relation Between Structural Vibrations and Radiated Sound

P. Sas, P. Vandeponseele, R. Snoeys
Katholieke Universiteit Leuven, Afdeling Mechanische Konstruktie en Produktie

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 853-865, 6 figs, 16 refs

KEY WORDS: Sound waves, Wave radiation

Two methods for estimating sound power radiated by mechanical structures are presented. Both methods are based upon a Helmholtz integral formulation and require knowledge of the geometry and modal characteristics of vibrating surfaces so that pressure on the surfaces can be computed. The first method is limited to flat surfaces; the second method is more general. The paper reviews principles of acoustic radiation, algorithms, and verification experiments.

85-774

Active Force Control in Machinery Noise

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Dept. of Ocean Engrg., Florida Atlantic Univ.

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 845-852, 4 figs, 5 refs

KEY WORDS: Machinery noise, Active vibration control

Large reduction in the noise radiated from machine structures can be obtained by either structural changes at the point of impact, termed passive control, or by active cancellation of the excitation force. Which of these two methods is most suitable in a particular noise problem depends on the shape of the excitation force pulse.

85-775

Aerodynamic Sound Generation by Turbulent Boundary Layer Flows Along Solid and Compliant Walls (Aerodynamische Schallerzeugung durch turbulente Grenzschichtströmung entlang starrer und weicher Wande)

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Z. Flugwiss. Weltraumforsch., 8 (3), pp 181-192 (May/June 1984), 5 figs, 43 refs

KEY WORDS: Sound generation, Fluid-induced excitation, Turbulence

The purpose of the paper is to review basic facts on noise generated by boundary layer flows over solid walls. The effect of compliant walls on noise generated by boundary layer flows is investigated. The question whether additional monopole-like and dipole-like sources are important with respect to noise radiation when nonlinear effects of wall motion are taken into account.

SHOCK EXCITATION

85-776

Surface Phenomena in a Three-Dimensional

Skewed Shock Wave/Laminar Boundary-Layer Interaction
G. Degrez, J.J. Ginoux
Universite Libre de Bruxelles, Brussels, Belgium
AIAA J., 22 (12), pp 1764-1769 (Dec 1984), 10 figs, 29 refs

KEY WORDS: Shock wave-boundary layer interaction, Parametric response

A parametric study of three-dimensional skewed shock wave/laminar boundary-layer has been performed at a Mach number of 2.25. The data indicate similarity in behavior of laminar and turbulent interactions. Both exhibit a region of conical flow and satisfy similar upstream influence correlations. A study of the behavior of the flow with increasing shock strengths led to the hypothesis of a gradual evolution of flow structure.

85-777
Constitutive Features of Solids at Shock-Wave Loading Rates
D.E. Grady
Sandia National Labs., Albuquerque, NM
Rept. No. SAND-82-792C, CONF-84052-21-1, 9 pp (May 22, 1984), DE84015715

KEY WORDS: Shock excitation, Constitutive equations

Solids subjected to high-velocity impact or explosive loading exhibit unusual transient and post-shock properties during the extremely brief period associated with the shock-wave risetime and release. Sophistication in physical and computational modeling is required to incorporate these effects in applied problems.

85-778
Steel Fibrous Concrete Under Seismic Loading
L. Minnetyan, G.B. Batson
Clarkson College of Technology, Potsdam, NY 13676
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 589-597, 5 figs, 1 table, 22 refs

KEY WORDS: Reinforced concrete, Steel, Seismic design

This study addresses the question of determining the contribution of steel fibers to the dynamic stiffness and strength of reinforced concrete members. Included are the effects of loading history and cracking. An experimental research program is currently in progress with the objective of identifying an appropriate mathematical model that can be used in earthquake resistant design.

85-779
Response of Secondary Systems in Structures Subjected to Transient Excitation
A.G. Hernried, J.L. Sackman
Univ. of Utah, Salt Lake City, UT 84112
Earthqkuake Engrg. Struc. Dynam., 12 (6), pp 737-748 (Nov/Dec 1984), 2 figs, 3 tables, 16 refs

KEY WORDS: Equipment response, Equipment-structure interaction, Seismic excitation

An analytical method based on matrix perturbation theory is developed. A natural frequency of the equipment is considered close or equal to a natural frequency of the structure. The proposed procedure is demonstrated for an example equipment-structure system. Computed results based on the method are in close agreement with results obtained through a Newmark time-integration scheme.

VIBRATION EXCITATION

85-780
Parametric Excitation in a Self-Exciting

System (1st Report, Behaviors in the Region of Subharmonic Resonance of Order 1/2)

S. Yano
Fukui Univ., 3-9-1, Bunkyo, Fukui, Japan
Bull. JSME, 27 (233), pp 2483-2491 (Nov 1984), 13 figs, 3 refs

KEY WORDS: Subharmonic oscillations, Self-excited vibrations, Van der Pol method, Parametric excitation

In a self-exciting system of Van der Pol type with the restoring force expressed as the product of a nonlinear function of deflection and a periodic function of time, parametric resonances and subharmonic vibrations can occur. Steady-state solutions in the regions of parametric resonance of first order and of subharmonic resonance of order 1/2 and stability are determined by a transformation to the rotating coordinate system and the averaging method. In the neighborhood of these resonances a beat phenomenon occurs; its amplitude is estimated by an approximate limit cycle Approximate solutions have high accuracy.

85-781

The Hydrodynamic Lubrication of Rough Surfaces Based on a New Perturbation Approach

K. Tønder
Univ. of Trondheim, Trondheim-NTH, Norway
J. Tribology, Trans. ASME, 106 (4), pp 440-447 (Oct 1984), 8 tables, 12 refs

KEY WORDS: Hydrodynamic lubrication, Surface roughness, Perturbation theory

The approach consists of an expansion of pressure by the perturbation parameter which is the ratio of the characteristic wavelengths across and along the direction of motion respectively. Zeroth components are those of Tonder's approximate theory. The terms are modified so as to remain finite at infinite perturbation parameter. The method is applicable to statistically symmetric cases and can be extended to two-sided roughness

85-782

Forced Liquid Oscillations in Paraboloid Containers

H.F. Bauer
Hochschule der Bundeswehr München, Fachbereich Luft- und Raumfahrttechnik, Werner-Heisenberg-Weg 39, D-8014 Neubiberg
Z. Flugwiss. Weltraumforsch., 8 (1), pp 49-55 (Jan/Feb 1984), 4 figs, 4 refs

KEY WORDS: Fluid-filled containers, Liquids, Harmonic excitation, Damping effects

Response of a liquid in an arbitrary partially filled tank of paraboloidal geometry to harmonic translational and roll excitation about its axis is determined. Free liquid surface elevation, pressure, and velocity distribution are determined as well as the force of the liquid on the container. Motion of the liquid is described as a simple mechanical model to which equivalent linear damping is introduced. Experimental results are in good agreement with theoretical values.

85-783

Seismic Response of Multiply Connected MDOF Primary and MDOF Secondary Systems

A.K. Gupta
North Carolina State Univ., Raleigh, NC 27695-7908
Nucl. Engrg. Des., 81 (3), pp 385-394 (Sept 1, 1984), 3 figs, 22 refs

KEY WORDS: Natural frequencies, Mode shapes, Coupled systems, Seismic response

New algorithms are presented to evaluate mode shapes and frequencies of a coupled system if mode shapes and frequencies of the uncoupled primary and secondary systems are given. These coupled mode shapes can be used to obtain the dynamic response of the total system if input to the primary system is known. This information can also be used to develop instructure response spectra at the connecting DOF and the correlation between motions at connecting DOF

85-784
Dynamic Decoupling of Multiply Connected MDOF Secondary Systems
A.K. Gupta, J.M. Tembulkar
North Carolina State Univ., Raleigh, NC 27695-7908
Nucl. Engrg. Des., 81 (3), pp 375-383 (Sept 11, 1984), 4 figs, 6 tables, 3 refs

KEY WORDS: Natural frequencies, Coupled systems

New algorithms are presented for approximately calculating changes in frequencies and responses of a primary system as a result of decoupling of a multiply connected MDOF secondary system. The algorithms yield accurate results in the range of interest of decoupling.

85-785
Dynamic Decoupling of Secondary Systems
A.K. Gupta, J.M. Tembulkar
North Carolina State Univ., Raleigh, NC 27695-7908
Nucl. Engrg. Des., 81 (3), pp 359-373 (Sept 11, 1984), 9 figs, 12 tables, 8 refs

KEY WORDS: Natural frequencies, Coupled systems

Dynamic analysis of primary systems must often be performed decoupled from the secondary system. It is necessary that decoupling does not significantly affect frequencies and response of primary systems. The practice consis.s of heuristic algorithms intended to limit frequency changes. Changes in both frequencies and the response are considered. Rational, but simple algorithms are derived to make accurate predictions. Material up to MDOF primary-SDOF secondary system is presented.

85-786
Lift Hysteresis of an Oscillating Slender Ellipse
M.A. Takallu, J.C. Williams, III
Old Dominion Univ., Norfolk, VA
AIAA J., 22 (12), pp 1733-1741 (Dec 1984), 4 figs, 22 refs

KEY WORDS: Cylinders, Aerodynamic loads

A theoretical investigation was conducted to determine the timewise variation of lift on a slender elliptic cylinder moving at uniform speed but oscillating in pitch. The analysis couples a potential flow calculation, including the effect of a vortical wake, for flow past the cylinder with a calculation of unsteady, two-dimensional, laminar boundary layer on the surfaces of the pitching ellipse. The hysteresis loops change direction as the mean angle of attack is increased through the angle of attack corresponding to maximum steady lift.

85-787
Alleviation of Observation Spillover in Continuous Structures
A.V. Metcalfe
The Univ. of Newcastle upon Tyne, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 97-106, 3 figs, 10 refs

KEY WORDS: Active vibration control

In the design of controllers the contamination of input to the observer by observation spillover causes stability problems. This paper proposes a method for estimating such contamination and allowing for it by augmenting the observer with a dynamic system that can be described as a disturbance observer.

85-788
Researches in Random Vibration
J.D. Robson
Univ. of Glasgow, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by

Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 621-638, 6 figs, 20 refs

KEY WORDS: Random vibrations, Ground vehicles, Road roughness

The aim of this lecture is to give an indication of the research in Random Vibration carried out at Glasgow University in the Department of Mechanical Engineering during the period 1965-1982. The work is divided into three parts. Application of basic theory to the responses of road vehicles to road roughness is discussed. General aspects of the multivariate responses of linear systems subjected to random excitation is also presented. Explained are problems in which simplifying assumptions of process Gaussianity and system linearity are not permissible.

85-789

Nonstationary Random Response of Nonlinear Structures to Nonstationary Random Excitation

C.W.S. To

The Univ. of Calgary, Calgary, Alberta, Canada T2N 1N4

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 261-270, 2 figs, 55 refs

KEY WORDS: Random response, Nonlinear theories, Antennas

This paper begins with a review of the state of the art of techniques used for random analysis of the response of general multi-degree-of-freedom (MDF) nonlinear mechanical systems to random excitation. Special attention is paid on methods applied to MDF nonlinear systems subjected to nonstationary random excitation. A new method is proposed and used to determine time-dependent variance of response of a quarter-scale physical model of a class of mast antennas. Computed results are included graphically.

85-790

Prediction of Smoothed Frequency Responses Using General Orthogonal Polynomials

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Dept. of Mechanical Engrg., Brunel Univ.

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 65-72, 2 figs, 6 refs

KEY WORDS: Vibration prediction, Stiffness coefficients, Polynomial analysis

Smoothed frequency responses describe vibration behavior without regard to resonant-antiresonant detail. The object of this paper is to show how they can be predicted from information about stiffness coefficients and masses using a series-expansion in general orthogonal polynomials.

85-791

Effects of Ultrasonic Vibration on the Wear Characteristics of a Carbon Steel: Analysis of the Wear Mechanism

H. Goto, M. Ashida, Y. Terauchi

Fukuoka Inst. of Tech., 811-2, Fukuoka, Japan

Wear, 94 (1), pp 13-27 (Feb 15, 1984), 10 figs, 15 refs

KEY WORDS: Ultrasonic vibration, Wear, Steel

A simple equation for wear rate is derived using the theories of adhesive wear and analytical results of vibration. Analytical predictions are in good agreement with experimental results. One factor affecting wear behavior under vibration is the contact time between specimens during one cycle of vibration. The amount of oxygen absorbed on rubbing surfaces with repeated dynamic contact loading also affects the wear rate.

MECHANICAL PROPERTIES

DAMPING

85-792
Reducing Acoustical Radiation from High-Speed Mechanisms by Judicious Material Selection: An Experimental Study
M. Sharif-Bakhtiar, B.S. Thompson
Michigan State Univ., East Lansing, MI 48824
ASME Paper No. 84-DET-49

KEY WORDS: Machinery noise, Noise reduction, Material damping

This comparative study demonstrates how surface accelerations of links, and hence machinery noise, can be reduced by using materials with high values of material damping for links. The study suggests that preliminary predictions of acoustical noise radiation from linkage machinery can be obtained from a vibrational analysis of the mechanism system before studying link surface accelerations.

85-793
Prediction of the Dynamic Properties of Carbon-Glass Fibre Sandwich Hybrid Laminated Composites
R.D. Adams, R.G. Ni, D.X. Lin
Univ. of Bristol, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 799-807, 8 figs, 12 refs

KEY WORDS: Sandwich structures, Beams, Plates, Damping effects

The purpose of this work is to predict the vibration damping and modulus of sandwich hybrid composite beams. Resonant frequency, vibration damping, and mode shape of sandwich hybrid composite plates in flexure are also predicted.

85-794
Digital Control System for Space Structural Dampers
J.K. Haviland
Rotor Dynamics Lab., Univ. of Virginia, Charlottesville, VA
Rept. No. UVA/528224/MAE85/102, NASA-CR-173867, 59 pp (July 1984) N84-31267

KEY WORDS: Dampers

A damper concept is improved by adding a small taper to the proof-mass and using a proximeter to determine position. Another damper using a three inch stroke is described. Provisions are made for a relative velocity feedback. In one approach, the digital controller is modified to accept the signal from a linear velocity transducer. In the other, the velocity feedback is included in the digital program. An overall system concept for the use of the dampers is presented.

85-795
Stochastic Seismic Sliding of Rigid Mass Supported through Non-Symmetric Friction
M.C. Constantinou, G. Gazetas, I. Tadjbakhsh
Rensselaer Polytechnic Inst., Troy, NY 12181
Earthquake Engrg. Struc. Dynam., 12 (6), pp 777-793 (Nov/Dec 1984) 8 figs, 5 tables, 34 refs

KEY WORDS: Coulomb friction, Seismic design, Dams, Base isolation

The sliding behavior of a rigid mass supported on a randomly vibrating foundation through a nonsymmetric Coulomb-friction contact is studied both analytically and by numerical simulation. Analytical results yield several exact asymptotic expansions for both small and large values of time. A Monte Carlo type numerical simulation study produces nonstationary response sta-

tistics in accord with analytical results. Gumbel's Extreme Value Distribution reproduces with remarkable accuracy the observed cumulative frequency of maximum slip displacement. Possible applications include seismic design of embankment dams, earth retaining walls, and base isolation systems.

85-796
Continuum Modelling of Damping in Large Space Structures
S. Abrate, C.T. Sun
School of Aeronautics and Astronautics, Purdue Univ., Lafayette, IN
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 877-885, 7 figs, 7 refs

KEY WORDS: Internal damping, Mathematical models, Continuum mechanics

Large Space Structures (LSS) are periodic lattices made up of a large number of elements. Passive damping in LSS assures stability of the active control system, allows for higher gains, and reduces the bandwidth. Sources of damping are many; internal damping is considered. Formulations of mathematical models are discussed, damping properties of equivalent continuum models are determined, and results are presented.

85-797
Extended Damping Models for Vibration Data Analysis
J.A. Fabunmi
Aerospace Engrg. Dept., Univ. of Maryland
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 521-533, 4 figs, 10 refs

KEY WORDS: Damping effects, Experimental modal analysis

This paper reexamines the way in which damping considerations enter the equations of motion for steady vibrations. A simple three-degree of freedom system requires a frequency domain system of equations; a damping matrix depends on both frequency and response levels. These equations are investigated numerically to study the effects of departures from linear damping models on the shape of the mobility functions.

85-798
Auxiliary Mass Damper for Cardan Suspended Gyro
J. Rosenberg, A. Kahana
A.D.A., P.O. Box 2250, Haifa, Israel
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 87-96, 8 figs, 11 refs

KEY WORDS: Gyroscopes, Damping

The article deals with a spin stabilized platform. In order to isolate the system from external moments it is suspended through its center of mass by means of a cardan. Damping should not impair isolation of the platform from its environment. The simplest model of a cardan suspended gyro involves only one natural frequency, termed the nutation. Several methods for nutation damping are discussed in the literature. The interaction between the stabilized platform and the damper is considered. This causes the appearance of three natural frequencies instead of the nutational frequency.

FATIGUE

85-799
Installing an Axial Extensometer on a Test Specimen
D. Holm

Deere & Co. Technical Ctr., Moline, IL
Exptl. Tech., 8 (12), p 33 (Dec 1984) 3 figs

KEY WORDS: Fatigue tests, Testing techniques

The point contact of an axial extensometer's knife edges on the surface of a low-cycle fatigue-test specimen can initiate a crack. The problem was solved by curing a small amount of epoxy on the gage section of the test specimen where the knife edges would normally make contact. The use of O-rings for elastic support makes soft contact with the specimen.

85-800
On-Line Fatigue Prediction under Stochastic Loading by Time Series Modeling
B.D. Notohardjono
Ph.D. Thesis, Univ. of Wisconsin-Madison, 295 pp (1984) DA8414252

KEY WORDS: Fatigue life, Stochastic processes, Computer aided techniques, Prediction techniques

This thesis introduces a new, on-line method for fatigue failure forecasts (FFF) by time series modeling of the correlated strain output of a fatigue process under stochastic loading. The new method can be used for on-line prediction of a potential fatigue failure without knowledge of the prior load history or the future loading pattern. Several illustrations demonstrating application of the FFF method and its accuracy are given.

85-801
Fatigue Limit Analysis Involving Biaxial Stress Components
E.G. Munday
Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 160 pp (1984) DA8417828

KEY WORDS: Fatigue life, Stress analysis

Biaxial stress fatigue data are examined in order to assess possibilities for a rational approach to classical stress-based fatigue limit analysis involving biaxial stress components. A review is given of the methods presently in vogue; new methods are suggested for obtaining equivalent mean and equivalent alternating stresses. The work is restricted to cases in which the alternating principal stress axes have fixed orientation.

85-802
Acoustic Fatigue Life of Adhesive Bonded Structures Subjected to Acoustic Loads
H.F. Wolfe, I. Holehouse
AFWAL/FIBE, Wright-Patterson Air Force Base, OH 45433
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 763-773, 18 figs, 6 refs

KEY WORDS: Acoustic fatigue, Composite structures, Bonded structures, Adhesives

A summary of the work completed in acoustic fatigue prediction techniques for weldbonded aluminum, adhesive bonded aluminum, and adhesive bonded graphite-epoxy structures is given. Prediction methods have been developed for certain failure modes in adhesive bonded aluminum and graphite-epoxy bonded skin-stiffened structures.

85-803
Dynamic Response and Acoustic Fatigue of Stiffened Composite Structure
J. Soovere
Lockheed-California Co., Burbank, CA
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 775-786, 22 figs, 4 tables, 15 refs

KEY WORDS: Acoustic fatigue, Composite structures, Stiffened structures, Experimental data

This paper summarizes the results obtained from acoustic fatigue and dynamic response tests and the L-1011 composite aileron and integrally stiffened Gr/E panels. The nature of the damping in integrally stiffened composite panels, its theoretical prediction, and its implication on internal noise are briefly discussed.

85-804
Applications of Integral Equations with Strong Singularities in Fracture Mechanics
A.C. Kaya
Ph.D. Thesis, Lehigh Univ., 287 pp (1984)
DA8418418

KEY WORDS: Crack propagation

The objective of this study is to investigate certain types of singular integrals that arise in the formulation of two-dimensional and three-dimensional crack problems. Various methods for the numerical evaluation of finite-part integrals with $1/(t-x)^2$ singularities and the approximate solution techniques for related integral equations are explained. A chronological review of literature on the three-dimensional crack problems is given and different solution methods are summarized.

ELASTICITY AND PLASTICITY

85-805
Measurement of Elastic Constants of Polycrystals by the Resonance Method in a Cylindrical Specimen
M. Senoo, T. Nishimura, M. Hirano
Nagoya Univ., Frou-cho, Chikusaku, Nagoya, Japan
Bull. JSME, 27 (233), pp 2339-2346 (Nov 1984) 5 figs, 2 tables, 5 refs

KEY WORDS: Elastic properties, Cylinders, Concentric structures, Resonance bar technique

An analytical method on a cylindrical specimen was developed to determine elastic constants. A finite element method was applied to concentric cylinders divided in the radial direction. Many resonant frequencies in a small cylindrical specimen were easily measured.

85-806
Stability and Vibrations of Internal Windings of High Current Superconducting Solenoid Magnets
K. Hara
Ph.D. Thesis, Cornell Univ., 171 pp (1984)
DA8415363

KEY WORDS: Magnetic coils, Elastic properties

The magnetic stiffness is shown to have a significant effect on the elastic stability and vibration of high-field solenoid magnets. One-turn and multi-turn superconducting rings were used to study the effects of deformations on stability and vibrations. Both static and dynamic methods were used to determine critical buckling currents. A model based on ring theory and magnetic stiffness was used to evaluate the buckling current of 7- and 10-turn magnets.

85-807
Interactions among System Stiffness, Wear and Vibrations
I. Shareef
Ph.D. Thesis, Illinois Inst. of Tech., 176 pp (1984) DA8418400

KEY WORDS: Stiffness effects, Wear, Friction

A fundamental investigation has been carried out to establish parametric relationships among friction, wear, and system stiffness. Results indicate that stiffness significantly affects transition from mild to severe wear and onset of self-excited vibrations, in both dry and water-lubricated sliding contact. Four regimes of friction and vibration were observed as functions of normal load and stiffness. Different types

of vibrations induced by dry friction were investigated. Wear is an increasing function of system stiffness. A wear model accounts for slider oscillation in the normal direction.

WAVE PROPAGATION

85-808

Transient Elastic Waves in a Wedge-Shaped Layer

F. Ziegler, Y.-H. Pao
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Acta Mech., 52 (3/4), pp 133-163 (Sept 1984) 2 figs, 6 refs

KEY WORDS: Elastic waves, Layered materials

The generalized ray theory is applied to transient elastic waves in a layered half-space with nonparallel interface. The propagation, reflection, and refraction of longitudinal and transverse waves are considered. Generalized ray integrals are formulated. Attention is given to wave mode changes during reflection. Arrivals of head waves corresponding to rays refracted at a fast bottom are calculated.

85-809

Growth and Decay of One-Dimensional Shock Waves in Multiphase Mixtures

P.A. Taylor
Sandia National Labs., Albuquerque, NM 87185

Acta Mech., 52, pp 239-267 (1984) 25 refs

KEY WORDS: Shock waves

Behavior of one-dimensional shock waves in a chemically reacting, nondiffusing multiphase mixture is examined. The shock-evolution equation determines local growth or decay of the shock wave. This equation accounts for immiscibility and energy exchange between constituents associated with microstructural properties of the mixture, as well as chemical reactivity at the shock front. Constituent Hugoniot properties within the context of a multiphase mixture theory are given.

85-810

The Magnetospatial and Electrospatial Dispersion Effects on Elastic Wave Propagation in Crystals

K. Kumaraswamy, N. Krishnamurthy
Madurai Kamaraj Univ., Madurai-625 021, India

J. Acoust. Soc. Amer., 76 (5), pp 1522-1526 (Nov 1984) 12 refs

KEY WORDS: Elastic waves, Electromagnetic waves, Wave propagation

Similarities in propagation characteristics of electromagnetic and elastic waves in crystals are brought out. In S_4 type of crystals rotation of major and minor axes of the elliptical state of polarization depends on magnetospatial and electrospatial dispersion terms in the respective fields. A birefringence depending quadratically on an applied electric field is induced in T_h type of crystals for parallel field configurations. In perpendicular field configurations longitudinal and transverse modes are coupled and exhibit an elliptical state of polarization.

85-811

Harmonic and Transient Scattering from Time Varying Obstacles

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J. Acoust. Soc. Amer., 76 (5), pp 1527-1534 (Nov 1984) 24 refs

KEY WORDS: Harmonic waves, Sound waves, Wave scattering, Perturbation theory

The method of inverse scattering is pertinent to mechanical as well as electromagnetic waves. Mathematically, the method is essentially a perturbation technique.

Representation in terms of algebraically manipulated compact symbolic differential operators avoids cumbersome detail. New spectral components and associated new poles are created due to time variation of the objects and facilitate identification of details of the motion.

85-812

Scattering of Elastic Waves by a Cylindrical Obstacle Embedded in a Multilayered Medium

G.R. Franssens, P.E. Lagasse
Univ. of Gent, Laboratory for Electromagnetism and Acoustics, Sint Pietersnieuwstraat 41, B-9000 Gent, Belgium
J. Acoust. Soc. Amer., 76 (5), pp 1535-1542 (Nov 1984) 10 figs, 24 refs

KEY WORDS: Elastic waves, Wave scattering, Cylinders, Layered materials

A numerical method is presented for the computation of reflection, transmission, and mode conversion coefficients for the scattering of both SH and P-SV waves by a cylindrical obstacle embedded in a multilayered medium. Scatterer and the surrounding medium are modeled by finite elements. Numerical results are presented for geometries occurring in underground seismic surveys of coal layers and in the design of surface acoustic wave devices.

85-813

Rayleigh Wave Velocity and Displacement in Orthorhombic, Tetragonal, Hexagonal, and Cubic Crystals

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Laboratoire d'Acoustoélectricité de l'Universite P. et M. Curie, 10, rue Vauquelin, 75231 Paris Cedex 05, France
J. Acoust. Soc. Amer., 76 (5), pp 1438-1444 (Nov 1984) 2 figs, 2 tables, 13 refs

KEY WORDS: Rayleigh waves, Wave propagation

The analysis of Rayleigh wave propagation in crystals is carried out in the cases for which, on the one hand, Christoffel equations split into two parts providing a Rayleigh wave polarized in the sagittal plane, and on the other hand, boundary conditions simplify under the conditions that some elastic constants vanish. These requirements are satisfied by 16 configurations in crystals belonging to the orthorhombic, tetragonal, cubic, and hexagonal symmetry systems. Curves showing the decrease of longitudinal and transverse components of the mechanical displacement are given.

85-814

Studies on the Scattering of Steady State and Transient Electromagnetic Waves by Imperfectly Conducting and Coating Structures

A.A. Sebak
Ph.D. Thesis, Univ. of Manitoba, Canada (1984)

KEY WORDS: Wave scattering, Electromagnetic waves

Impedance boundary conditions are used with the method of moment to develop a simple and efficient numerical procedure for treating problems of electromagnetic scattering from finite, imperfectly conducting and coated objects. An approximate method for treating the problem of scattering from arbitrarily-shaped objects is presented. Frequency domain data are transformed to the time domain.

85-815

Forced Oscillations of Transonic Channel and Inlet Flows with Shock Waves

A.F. Messiter, T.C. Adamson, Jr.
Univ. of Michigan, Ann Arbor, MI
AIAA J., 22 (11), pp 1590-1599 (Nov 1984) 3 figs, 16 refs

KEY WORDS: Shock waves, Wave propagation

In transonic channel or inlet flow, large-amplitude motions of a shock wave can be caused by small-amplitude oscillations of

the walls or back pressure. Asymptotic solutions are obtained for velocity and pressure distributions throughout a two-dimensional channel. Solutions for the shock-wave velocity are derived. Problem formulation and solution depend on the relative orders of magnitude of the non-dimensional amplitude and frequency of the impressed oscillations. Numerical results are shown for examples.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

85-816
Analysis of Vibration by Component Mode Synthesis Method (Part 5, Forced Vibration II)
M. Ookuma, A. Nagamatsu, S. Yanabe
Tokyo Inst. of Tech., 12-1, Ohokayama 2-chome, Meguro-ku, Tokyo, Japan
Bull. JSME, 27 (232), pp 2219-2225 (Oct 1984) 19 figs, 4 tables, 6 refs

KEY WORDS: Component mode synthesis, Mode shapes, Finite element technique

A method is presented to analyze the vibration of a complex mechanical structure by using the natural modes of its components. The natural modes of each component in the condition of its interface region are calculated by the finite element method. Vibration of a continuous centrifuge is analyzed. Calculated results are compared with experimental ones.

85-817
The Improvement of Free-Mode Methods in Component Mode Synthesis Techniques and Its Accuracies
Z.W. Wang, M. Petyt
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 221-228, 5 figs, 8 refs

KEY WORDS: Component mode synthesis

Free-mode methods in component mode synthesis techniques are improved by use of the concept of positive static residuals, which are developed according to theorems given in this paper. The technique of assembly of complicated structures is also presented. Convergence of the improved free-mode method is related to the eigen-frequency coefficient. It is generally larger than 1.0 and smaller than 1.4.

85-818
Modal Synthesis of Large Structures with Nonlinear Joints from Vibration Tests
L. Jezequel
Département de Mécanique des Solides, Ecole Centrale de Lyon, Ecully - 69130 - France
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 281-295, 3 figs, 2 tables, 39 refs

KEY WORDS: Modal synthesis, Experimental data, Vibration tests, Nonlinear theories

Three modal synthesis methods allowing identification of nonlinear joint models from vibration tests are given. Each method uses one of two substructure models that describe linear dynamic behavior and define generalized boundary displacements. The first method, the constrained mode set, is based on a dynamic transformation. The second method uses the notion of nonlinear modes; they can be identified by a method based on the Ritz-Galerkin procedure. This method permits definition of a nonlinear joint model from an identification of Volterra kernels and a correlation analysis.

85-819

Application of Modal Synthesis Concepts to Spacecraft Design Verification

A. Bertram

DFVLR/AVA Göttingen, Institut f. Aeroelastik, Göttingen, Fed. Rep. Germany

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 395-414, 10 figs, 28 refs

KEY WORDS: Modal synthesis, Spacecraft, Design techniques

FE-models are an efficient tool to study the dynamic behavior of a structure in early phases of development. A mathematical model is a reliable tool only when it is verified by means of the dynamic behavior of a realistic structure. Selected experiments must be performed. Minimization of experimental and analytical efforts in the design verification procedure -- i.e., a combined procedure -- is the goal of this study.

85-820

A Modified Modal Method for Nonlinear Dynamic Analysis of Structures

N.F. Knight, Jr.

Ph.D. Thesis, George Washington Univ., 308 pp (1984) DA8417859

KEY WORDS: Modal analysis, Curved beams, Plates, Shells

A computational procedure is presented for predicting the dynamic response of curved beams, plates, and shells with geometric nonlinearities and subjected to a step loading. The mathematical formulation is based on a modified form of the Hellinger-Reissner mixed variational principle. A modified modal method substantially reduces the total number of degrees-of-freedom. The modified method combines contemporary finite elements and the classical Rayleigh-Ritz technique. Application of the procedure to planar structures and curved-surface structures subject to a step loading is presented.

85-821

Life Time Prediction Based on the Combined Use of Finite Element and Modal Analysis

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"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 809-823, 11 figs, 4 tables, 7 refs

KEY WORDS: Modal analysis, Finite element technique

Strain and stress distribution for a particular modal deformation pattern for part or all of a structure are calculated using a finite element model. Stresses and strains are found for each mode and combined to derive stress and strain histories. The life time is found from the number of loading sequences that can be applied to satisfy fatigue failure criterion. This procedure allows evaluation of the influence on life time of various modifications in structural design, material properties, and other factors.

85-822

Modal Analysis and Identification of Structural Non-Linearity

G.R. Tomlinson, N.E. Kirk

Simon Engrg. Labs., Univ. of Manchester, UK

"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 495-510, 10 figs, 10 refs

KEY WORDS: Modal analysis, System identification techniques, Nonlinear systems

The testing method most commonly used in the identification of nonlinear structures is the single frequency sinusoidal input. The principal limitation regardless of the testing procedure employed is that, in order to

analyze nonlinear structures, important assumptions have to be made. A recently developed method overcomes several of these shortcomings. It employs the Hilbert transform, which provides a relationship between real and imaginary parts of the measured complex frequency response functions.

85-823
Feasibility of Using Modal Analysis Techniques for Nonlinear Multidegree of Freedom Systems
R. Singh, C. Nopporn, H. Busby
Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 483-493, 12 figs, 2 tables, 14 refs

KEY WORDS: Experimental modal analysis, Nonlinear systems

The focus of this paper is to examine the feasibility of using conventional modal analysis techniques for cases in which a structure is inherently nonlinear or when vibratory amplitudes are no longer small.

85-824
A Flexible Multichannel Measurement System for Dynamic Analysis
H. Van der Auweraer, P. Van Herck, R. Snoeys
Katholieke Universiteit Leuven, Belgium
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 415-425, 4 figs, 10 refs

KEY WORDS: Experimental modal analysis, Instrumentation

The goal was to design a multichannel data-acquisition system front-end for an H.P.1000 computer (Digital Data Harvester) that would be expandable and flexible enough to be used with many mini- and microcomputers. The design of this system is related to the evolution of Fourier analysis equipment.

85-825
Galileo Spacecraft Modal Test and Evaluation of Testing Techniques
Jay-Chung Chen
Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 749-761, 8 figs, 14 tables, 5 refs

KEY WORDS: Spacecraft, Experimental modal analysis

Galileo spacecraft modal test requirements are described. Associated pre-test activities from which the test is designed are presented.

85-826
Determination of Receptances of Locally Damped Structures
H.N. Ozguven
Middle East Technical Univ., Ankara, Turkey
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 887-892, 1 table, 12 refs

KEY WORDS: Mobility method, Damped structures

A method is proposed for computation of the receptances of a nonclassically-damped structure from undamped counterparts. The counterparts can be obtained from undamped modal data. A numerical example is given.

85-827

Foolproof Methods for Frequency Response Measurements

H.G.D. Goyder
U.K.A.E.A. Harwell
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 437-446, 8 figs, 6 refs

KEY WORDS: Frequency response function, Measurement techniques, Harmonic excitation, Periodic response

It is the objective of this paper to present three techniques that greatly enhance the accuracy and precision of structural vibration measurements. The measurement techniques considered relate to the frequency response function or transfer function that expresses the steady-state response of a structure to a harmonic excitation.

85-828

Time Domain Analysis of Nonlinear Vibration Data

S.F. Masri, R.K. Miller, H. Sassi, T.K. Caughey
Univ. of Southern California, Los Angeles, CA
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 511-520, 9 figs, 7 refs

KEY WORDS: Time domain method, Approximation methods, Nonparametric identification technique, Nonlinear systems

This paper presents an approximate method for the time-domain analysis of vibration data obtained from the response of multi-degree-of-freedom dynamic systems undergoing nonlinear deformations. The proposed data-processing method provides a convenient procedure for the nonparametric identification of arbitrarily nonlinear structural systems. The method furnishes a rational approach for a systematic procedure of model-order reduction in nonlinear systems.

85-829

The Experimental Measurement of Flexural Wave Power Flow in Structures

W. Redman-White
Inst. of Sound and Vib. Res., Univ. of Southampton, UK
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 467-474, 6 figs, 7 refs

KEY WORDS: Flexural waves, Wave energy, Beams, Measurement techniques

The concept of wave intensity is defined as the power flow per unit width of cross section area (in a uniform plate). In beams the power flowing through the total cross section is considered. If it is possible to obtain repeated measurements of intensity at many points on a structure, a pattern of power flow can be identified. Power carried by flexural waves is considered; it is theoretically more difficult to measure than power due to other wave types. Many of the arguments developed can be applied to other wave types.

85-830

Measuring of Revolutions by an Optimal PLL Circuit (Drehzahlmessung mit Hilfe einer optimalen PLL-Schaltung)

T. Vikopoulos
Technische Universität München, Theresienstrasse 90, D-8000 Munchen 2, Fed. Rep. Germany
Techn. Messen.-TM, 51 (10), pp 368-374 (Oct 1984) 7 figs, 2 tables, 9 refs (In German)

KEY WORDS: Machinery vibrations, Torsional vibrations, Vibration measurement

The method is suitable for measuring torsional vibrations in sets of machines. A

pulse series is generated. Frequency is proportional to the number of revolutions. The phase-locked loop (PLL) provides an output voltage proportional to this frequency. Angular velocity measurements for an induction motor are presented. Sinusoidal slip fluctuations with a frequency up to 50 Hz (100 Hz) are transmitted with a phase error of less than 10° (20°).

85-831

Acquisition, Transmission and Processing of Measuring Data on a Cam-Cam Follower Testing Machine (Erfassung, Übertragung und Verarbeitung von Messdaten an einem Nocken-Stössel-Prüfstand)

W. Burger, D. Frey, H. Baumann, R. Haller
Institut f. Maschinenkonstruktionslehre, Universität Karlsruhe, Kaiserstr. 12, D-7500 Karlsruhe, Fed. Rep. Germany

Techn. Messen.-TM, 51 (10), pp 356-361 (Oct 1984) 13 figs, 9 refs (In German)J

KEY WORDS: Measurement techniques, Elastohydrodynamic properties, Cam followers

The method allows measurement of pressure and temperature in an unsteady elastohydrodynamic contact (cam-cam follower testing machine) using evaporated transducers. Due to the great number of operating parameters and the limited durability of the transducers in the contact, it is necessary to obtain as many measuring data as possible in the shortest possible time. Using the described measuring technique, more than five millions of measuring data can be recorded and stored in 100 seconds.

85-832

Experimental Study of Soil-Structure Interaction at an Accelerograph Station

C.B. Crouse, G.C. Liang, G.R. Martin
Earth Technology Corp., 3777 Long Beach Blvd., Long Beach, CA 90807

Bull. Seismol. Soc. Amer., 74 (5), pp 1995-2012 (Oct 1984) 7 figs, 20 refs

KEY WORDS: Soil-structure interaction, Accelerographs, Earthquake response, Vibration tests, Experimental data

Forced harmonic vibration tests, using eccentric mass shakers, were conducted at the Jenkinsville, SC accelerograph station to determine effect of soil-structure interaction on motions recorded during four small magnitude earthquakes. Results suggest that careful attention must be given to the design of accelerograph stations if they are to record true ground motions over a wide frequency range.

85-833

Storing Measuring Device Capable of Interpolative Signal Reconstruction (Speichernde Messeinrichtung mit interpolativer Signalrekonstruktion)

A. Bayati, M. Henle
Siemens AG E STE 212, Ostliche Rheinbruckenstrasse 50, D-7500 Karlsruhe 21, Fed. Rep. Germany

Techn. Messen.-TM, 51 (10), pp 362-367 (Oct 1984), 10 figs, 7 refs (In German)

KEY WORDS: Measuring instruments, Recording instruments, Periodic response, Transient response

The system measures periodic or transient analog signals. The stored signal is reconstructed by a hardware interpolation procedure. It is possible to reduce the sampling frequency to 2.5 times the highest signal frequency. The system can be built with low-cost components or the bandwidth can be expanded when faster components are used. A comparison of results with systems using software interpolation methods is included.

85-834

Variable Pulse Width Piezoelectric Ultrasonic Transducer Driver

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AERE Harwell, Didcot, Oxfordshire OX11 ORA, UK

NDT Intl., 17 (4, pp 209-213 (Aug 1984), 8 figs, 3 refs

KEY WORDS: Transducers, Ultrasonic techniques

Requirements of ceramic piezoelectric ultrasonic transducer drive circuits are discussed in the light of advanced nondestructive testing techniques. A new drive circuit based upon power MOSFET devices overcomes many of the shortcomings of capacitor discharge circuits. This driving technique enables transducers of a wide range of resonant frequencies to be driven from a single drive unit. It also allows optimization of transducer characteristics by control of the drive pulse shape.

85-835
Practical Aspects of Piezoelectric Ceramic Load Cells
V.N. Bindal, J.N. Som, A. Kumar
National Physical Lab., New Delhi-110012, India
Trans. Inst. Mech. E., 6 (1), pp 53-56 (Jan/Mar 1984), 1 table, 10 refs

KEY WORDS: Piezoelectric transducers

A lead-zirconate-titanate disc, with a double electrode system, has been used as a sensing element in a piezoelectric ceramic load cell. Variations in output voltage at a fixed frequency and the shift in resonant frequency with change in load are measured. Effects of various parameters on the performance of loadcell linearity, temperature stability, and repeatability are discussed.

DYNAMIC TESTS

85-836
An Investigation of the Behavior of the Simultaneous Three Axis Vibration System
G.K. Hobbs, R. Mercado
Santa Barbara Res. Ctr.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 447-456, 25 figs, 3 refs

KEY WORDS: Shakers, Test equipment, Time domain method, Frequency domain method

To more thoroughly understand the behavior of the quasi-random multiaxis shaker, investigations of motions in the time and frequency domains were undertaken. Relationships of the three linear axes and the three rotational axes were studied. These six axes of motion can be considered independent in terms of specimen response to input motions.

85-837
Recent Experimental Devices to Obtain the Dynamic Parameters of Bridges
W.C. McCarthy, K.R. White, A.G. Arroyo
New Mexico State Univ.
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 457-465, 7 figs, 4 refs

KEY WORDS: Bridges, Testing instrumentation, Natural frequencies, Damping coefficients

The tricoil sensor was designed to measure movement in three orthogonal directions and is superior to its counterpart, the accelerometer. The vibration machine complements the tricoil sensor with its operator control and operational flexibility. This paper describes both instruments including their composition, how they work, and their functional capacities.

85-838
Vibration Damage Testing of Thermal Barrier Fibrous Blanket Insulation
W.E. Black, W.S. Betts
GA Technologies, P.O.Box 81608, San Diego, CA 92138
Nucl. Engrg. Des., 80 (3), pp 375-383 (Aug 1, 1984), 8 figs, 6 refs

KEY WORDS: Thermal insulation, Nuclear reactor components, Acoustic tests

This is the third in a series of acoustic tests. Two sizes of thermal barrier coverplates with one fibrous blanket insulation type were tested in an acoustic environment at sound pressure levels up to 160 dB. Three tests were conducted using sinusoidal and random noise for up to 200 h duration at room temperature. Most of the damage done to the insulation was caused by small beads of shot that vibrated sufficiently to enlarge holes several times the particle diameter. None of the holes caused by normal shot was sufficiently damaging to render the insulation ineffective.

DIAGNOSTICS

85-839
EWGAE Codes for Acoustic Emission Examination: Code II —Leak Detection, Code III — Examination of Small Parts
NDT Intl., 17 (4), pp 215-220 (Aug 1984)

KEY WORDS: Diagnostic techniques, Acoustic emission, Measurement techniques, Standards and codes

The two codes are designed to be of use to owners of pressurized installations and owners of structures and components under overload test, the regulating insurance agency concerned and the acoustic emission examining body. They give recommended practices for leak detection when only continuous noise is measured; and examination of small parts, for which monitoring without including location facilities can be considered sufficient.

85-840
How to Distinguish Surface and Subsurface Cracks Using Electromagnetic NDT Methods
B. Brudar
Iron and Steel Works, 64270 Jesenice, Yugoslavia
NDT Intl., 17 (4), pp 221-223 (Aug 1984) 2 figs, 9 refs

KEY WORDS: Diagnostic techniques, Crack detection, Electromagnetic properties

This paper outlines physical principles of a method for distinguishing surface cracks from subsurface cracks. The method is based on determining changes in amplitude and phase of a magnetic flux over a cross section in a metal bar containing defects. Due to impedance effects, for surface or subsurface cracks the resultant magnetic fields have phases that lead and lag respectively the field from a bar with no defects.

85-841
Rotor Dynamics of Turbomachinery
A.V. Ruddy
Dept. of Applications Engrg., Glacier Metal Co. Ltd.
Indus. Lubric. Trib., 36 (2), pp 66-70 (Mar/Apr 1984) 3 figs, 2 refs

KEY WORDS: Diagnostic techniques, Failure detection, Turbomachinery

This paper describes factors affecting dynamic behavior of a turbomachine rotor and the importance of accounting for dynamic characteristics of different machine elements. A brief review of available analytical techniques is given.

BALANCING

85-842
A Computer Program for Engine Balancing
B. Law
Perkins Engines
Auto Engr. (UK), 9 (2), pp 44-46 (Apr/May 1984) 5 figs, 2 tables

KEY WORDS: Balancing techniques, Engines, Computer programs

The requirement for rapid engine balance assessment has been met by a computer program. This program can further the

understanding of engine excitation and balance. This work extends classic balancing theory to meet the requirements of the working designer in the development of new engines.

and connectors, charge amplifiers, and signal conditioning and monitoring are considered. Examples are given of the benefits experienced with the final system.

MONITORING

85-843
Operational Mode Monitoring of Gas Turbines in an Offshore Gas-Gathering Application
D.F. Toler, R.N. Yorio
Ingersoll-Rand Co., Phillipsburg, NJ 08865
J. Engrg. Gas Turbines Power, Trans. ASME, 106 (4), pp 940-945 (Oct 1984) 8 figs, 1 table, 7 refs

KEY WORDS: Monitoring techniques, Offshore structures, Gas turbines, Fatigue life

A computer-assisted monitoring system has been implemented on GT-61 gas turbines employed in offshore gas gathering. Data acquisition hardware, data reduction software, and life prediction techniques are described. The fatigue life predictions reaffirm the suitability of the GT-61 for this more severe service.

85-844
Development of a Case Vibration Measurement System for the DC-990 Gas Turbine
H.A. Kidd
Dresser Clark Div., Dresser Industries, Olean, NY
J. Engrg. Gas Turbines Power, Trans. ASME, 106 (4), pp 935-939 (Oct 1984) 8 figs, 2 refs

KEY WORDS: Monitoring techniques, Gas turbines

This paper discusses the application of case vibration monitoring systems and the design criteria for each component. Engine installation, transducer mounting brackets, types of transducers, interconnecting cables

85-845
Early Detection of Damage in Rolling Bearings
E. Volker, H.R. Martin
Univ. of Waterloo, Ontario, Canada
ISA Trans., 23 (3), pp 27-32 (1984) 5 figs, 1 table, 6 refs

KEY WORDS: Monitoring techniques, Rolling contact bearings

This paper reviews some bearing condition monitoring and discusses new investigations. It develops the close links of metallography, tribology, noise, vibration analysis, and signal processing. Spectral analysis and time domain analysis are discussed.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

85-846
Dynamics of Constrained Flexible Systems Using Consistent, Lumped and Hybrid Mass Formulation
A.A. Shabana
Univ. of Illinois at Chicago, Chicago, IL 60680
ASME Paper No. 84-DET-125

KEY WORDS: Constrained structures, Inertial forces, Mathematical models

This paper is concerned with modeling inertia properties of flexible components that undergo large angular rotations. The formulation accounts for inertia coupling between gross motion and elastic deforma-

tion of flexible components in multi-body systems. A unified mathematical model and a unified computer program that deal with different formulations are developed. A comparative study is presented.

85-847
An Averaging Technique for the Analysis of Oscillations in Abruptly Nonlinear Systems
R.K. Miller, M.A. Heidari
Univ. of Southern California, Los Angeles, CA 90089-1113
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 297-306, 8 figs, 9 refs

KEY WORDS: Averaging techniques, Equivalent linearization method, Vibro-impact systems

An approximate technique, based on a new generalization of the method of equivalent linearization, is presented for analysis of oscillations in such abruptly nonlinear systems as those involving vibroimpact between adjacent structures. The new method introduces a weighting function into the averaging integrals used in the familiar method of equivalent linearization. An approximate amplitude-frequency response curve of adequate accuracy can be obtained.

85-848
Locality Principle in Structural Dynamics
A.K. Belyaev, V.A. Palmov
Polytechnical Inst., Leningrad, USSR
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 229-238, 6 refs

KEY WORDS: Locality principle

The vibration of a complicated mechanical object is investigated by a precise consideration of a particular element and an integral consideration of the rest of the object by the locality principle. The locality principle works in the high frequency band because the relative spectrum density is high there. It is also absolutely valid for systems with a continuous spectrum. In this case any damping value is sufficient.

85-849
Calculation of Eigenvalues Using Substructures and Dynamic Condensation
N. Petersmann
Institut f. Mechanik, Universität Hannover, Hannover, W. Germany
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 211-219, 7 figs, 2 tables, 7 refs

KEY WORDS: Substructuring methods, Condensation method

This paper deals with the application to dynamic problems of subdivision of a complete structure into appropriate substructures and exact reduction of the number of degrees of freedom to the number of boundary degrees of freedom. Eigenvalues and eigenvectors with the reduced number of equations are calculated.

85-850
Damped Oscillations Modeled by a 3-Dimensional Time Dependent Differential System
G.N. Bojadziev, C.K. Hung
Dept. of Math., Simon Frazer Univ., Burnaby, Canada V5A 1S6
Acta Mech., 53, pp 101-114 (1984) 4 figs, 10 refs

KEY WORDS: Damped structures, Nonlinear systems, Harmonic excitation

A technique based on the Krylov-Bogoliubov-Mitropolskii asymptotic method is

developed to investigate a weakly nonlinear mechanical system with strong damping. The technique is applied to an elastic system with internal friction and relaxation under the action of a harmonic force. The resonance curve is sketched; stability of the stationary regime of oscillations is examined.

85-851
A Simple Form Synthesis of Linear Time-Variant Digital Filter via Spectral Decomposition of Its Impulse Response
S. Park, J.K. Aggarwal
Univ. of Texas at Austin, Austin, TX 78712
Franklin Inst., 318 (3), pp 151-164 (Sept 1984) 4 figs, 2 tables, 18 refs

KEY WORDS: Digital filters, Impulse response

The paper describes a new technique to synthesize a finite impulse response of a linear time-variant (LTV) digital filter. Direct implementation of a decomposed impulse response leads to the parallel connection of linear time-invariant (LTI) digital filters that is followed by time-varying multipliers. A simple filter structure is obtained by modifying the sequences to the parallel form structure. The structure is easy to implement on a computer. Numerical examples illustrating the technique are included.

85-852
An Intrinsic Method of Harmonic Analysis for Non-Linear Oscillations (A Perturbation Technique)
A.S. Atadan, K. Huseyin
Univ. of Waterloo, Waterloo, Ontario, Canada
J. Sound Vib., 95 (4), pp 525-530 (Aug 22, 1984) 7 refs

KEY WORDS: Harmonic analysis, Perturbation theory, Periodic response

The method is designed to overcome the shortcomings of the conventional method of harmonic balance. It is a perturbation method and eliminates the possibility of omitting any possible contributions of various harmonics to a particular approximation. The approach yields ordered forms of consistent approximations for the nonlinear problem without requiring knowledge about the number of harmonics a priori, in contrast to the conventional technique.

MODELING TECHNIQUES

85-853
Limitations on the Identification of Discrete Structural Dynamic Models
A. Berman
Kaman Aerospace Corp., Bloomfield, CT
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 427-435, 1 fig, 1 table, 14 refs

KEY WORDS: Mathematical models, Parameter identification technique

Rarely has there been any discussion of the physical relationships between an analytical model and test data that tend to limit application of mathematically correct algebraic relationships. The purpose of this paper is to identify some of the limitations with the objective of directing research in more productive directions.

85-854
Use of Strain Energy Density as a Basis for Finite Element Model Development
A.H. Patel, R. Ali
Dept. of Transport Technology, Univ. of Technology, Loughborough
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 179-188, 7 figs, 2 tables, 11 refs

KEY WORDS: Mathematical models, Finite element technique, Strain energy density

The paper examines the use of a strain energy density distribution within deformed structures as a criterion for the development of progressively refined finite element models. This criterion has been used to study the dynamic characteristics of a cantilever beam and a diesel engine sump pan. The technique has been used to identify regions within the deformed structure that require more comprehensive modeling considerations.

NONLINEAR ANALYSIS

85-855
Extension of Transfer-Matrix Methodology to Nonlinear Problems
J.W. David, L.D. Mitchell
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 271-280, 7 figs, 11 refs

KEY WORDS: Nonlinear theories, Transfer matrix method

Transfer matrices can be modified for use in solving nonlinear problems. For the problems investigated here the nonlinear transfer-matrix approach appears to accurately predict system response except in small frequency regions where the numerical convergence indicates a residual error. This error indicator can be used to flag regions in which significant error can be expected. Even in error regions results by the transfer matrix method show trends of the solution.

85-856
Recent Advances in Reduction Methods in Non Linear Structural Dynamics
S.R. Idelsohn, A. Cardona
Mechanics Lab. of INTEC, P.O. Box 91-3000 Santa Fe, Argentina
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. II, pp 475-482, 7 figs, 6 refs

KEY WORDS: Reduction methods, Nonlinear systems

The paper pursues development of a new technique of reduction that applies to nonlinear dynamics. It consists of adding derivatives of displacements with respect to the modal amplitude parameters to the basis obtained by local mode superposition. The derivatives can be taken to various orders. This basis adequately approximates system behavior with a very limited number of degrees of freedom and with a very limited number of updatings. The reduced system is integrated by Newmark's implicit algorithm.

NUMERICAL METHODS

85-857
The Numerical Solution of Discontinuous Structural Systems
W.K.D. Borthwick
Dept. of Mech. Engrg., Univ. of Dundee
"Recent Advances in Structural Dynamics," Proc. of 2nd Intl. Conf., April 9-13, 1984, Univ. of Southampton, England. Spons. by Inst. of Sound and Vib. Res., Univ. of Southampton, Vol. I, pp 307-316, 5 figs, 16 refs

KEY WORDS: Numerical analysis, Discontinuity-containing media

This paper presents a numerical method, based on the classical fourth order Runge-Kutta process that is suitable for solving systems of ordinary differential equations with discontinuous right hand sides. These could include structural systems with discontinuous stiffness, mass or damping, or

any system whose discontinuous characteristics can be expressed in terms of discontinuity functions. A new inverse interpolation scheme is proposed for locating points of discontinuity.

A state estimation problem and a joint problem of state estimation and parameter identification of nonlinear distributed parameter systems (e.g., systems described by partial differential equations) were studied.

PARAMETER IDENTIFICATION

85-858
Parameter Identification of a Class of Time-Varying Systems via Orthogonal Shifted Legendre Polynomials
Chyi Hwang, Tong-Yi Guo
National Cheng Kung Univ., Tainan, Taiwan 700, Rep. of China
J. Franklin Inst., 318 (1), pp 59-69 (July 1984) 2 tables, 24 refs

KEY WORDS: Parameter identification technique

A method of orthogonal shifted Legendre polynomials for identifying the parameters of a process whose behavior can be modeled by a linear differential equation with time-varying coefficients in the form of finite-order polynomials is presented. It is based on the repeated integration of a differential equation. The differential input-output equation is converted to a set of overdetermined linear algebraic equations for a least squares solution. Results of simulation studies illustrate applic-bility of the method.

85-859
State Estimation and Parameter Identification: An Approach Involving a Pair Consisting of the Initial State and the Trajectory
J.A.M.F. Desouza
Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil
Rept. No. INPE-3183-PRE/548, 8 pp (July 1984) N84-31995

KEY WORDS: Parameter identification technique, Continuous parameter method

DESIGN TECHNIQUES

85-860
Simultaneous Optimization of Kinematic and Dynamic Characteristics in the Design of Planar Mechanisms
A.J. Kakatsios, S.J. Tricamo
Stevens Inst. of Tech., Hoboken, NJ
ASME Paper No. 84-DET-43

KEY WORDS: Mechanisms, Optimum design

This new approach to the design of high-speed planar mechanisms makes possible the synthesis of a linkage to satisfy prescribed kinematic criteria while simultaneously minimizing each of its dynamic reactions. The advantage to using the method is illustrated by application of the technique to the synthesis of a path generating linkage with coordinated input crank rotations.

COMPUTER PROGRAMS

85-861
Interactive Microcomputer Package for the Dynamic Analysis of Machines
D.D. Ardayfio, J.P. Mittler, A.S. Park
Univ. of Missouri-Rolla, Rolla, MO
ASME Paper No. 84-DET-9

KEY WORDS: Four bar mechanisms, Gears, Computer programs

The program for the four bar mechanism determines joint reactions and input torques in a given configuration of the mechanism. This program can also determine kinematic quantities during a cycle of

operation of the crank. The program for gear analysis consists of three programs for performing the kinematic and dynamic analysis of compound, epicyclic, and planetary gear trains.

85-862
The Dynamic Simulation of a Moving Vehicle Subject to Transient Steering Inputs Using the ADAMS Computer Program
J.B. McConville, J.C. Angell
Clark Equipment Co. ITD
ASME Paper No. 84-DET-2

KEY WORDS: Ground vehicles, Simulation, Computer programs

The ADAMS program simulates a complete materials handling vehicle going through two maneuvers. Nonlinear effects associated with the drivetrain, tire/ground interaction, and suspension/steering are included. The results of the simulation are compared with an instrument vehicle performing the same maneuvers.

85-863
TPLOT: An Interactive Time Plot System for Transient Structural Problems
J.P. Halleux
Joint Res. Centre, Commission of the European Communities, Ispra, Italy
Rept. No. EUR-8391, 49 pp (1983)
DE84700989

KEY WORDS: Data processing, Transient response, Computer programs

Interfaces that allow output of transfer data from programs and experiments to the data base are presented, as are modifications and additions of commands to render the system more suited to fast structural dynamics problems. Adequate data management command procedures have been developed for creating, saving and restoring.

GENERAL TOPICS

USEFUL APPLICATIONS

85-864
Fluctuation of Oil Film Pressure with Eccentricity and Waviness Considering Cylinder's Vibration
Y. Terauchi, T. Nonishi
Hiroshima Univ., Shitami, Saijo-cho, Higashi-Hiroshima, Japan
Bull. JSME, 27 (233), pp 2560-2567 (Nov 1984) 15 figs, 1 table, 5 refs

KEY WORDS: Oil film, Lubrication, Vibratory techniques

A spring was fixed to one end of the plate on a test cylinder; the test cylinder was allowed to move up and down. If eccentricity and waviness occur, the oil-film pressure fluctuates and the test cylinder vibrates. Experimental values of the oil-film pressure and the vibration of the cylinder were compared with values calculated considering eccentricity and waviness of the test cylinder.

AUTHOR INDEX

CALENDAR

MAY

6-8 4th International Symposium on Hand-Arm Vibration [Finnish Inst. of Occupational Health] Helsinki, Finland (I. Pyykko, Inst. of Occupational Health, Laajaniityntie 1, 01620, Vantaa 62, Finland)

6-9 American Society of Lubrication Engineers, 40th Annual Meeting [ASLE] Las Vegas, NV (ASLE)

22-24 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] New Orleans, LA (Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)

JUNE

3-5 NOISE-CON 85 [Inst. Noise Control Engrg./Ohio State Univ.] Columbus, OH (NOISE-CON 85, Dept. of Mech. Engrg., Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210 - (614) 422-1910)

19-21 American Control Conference [ASME] Boston, MA (ASME)

24-26 2nd National Conference and Workshop on Tailoring Environmental Standards to Control Contract Requirements [IES] Leesburg, VA (IES)

24-26 Mechanics Conference [ASME/-ASCE] Albuquerque, NM (ASME/ASCE)

JULY

2-4 Ultrasonics International '85, Kings College, London (Z. Novak, Ultrasonics, P.O. Box 63, Westbury House, Bury St., Guildford, Surrey GU2 5BH, England)

11-13 International Compressor Engineering Conference, Lafayette, IN (Purdue Univ., W. Lafayette, IN - (317) 494-2132)

AUGUST

4-8 International Computers in Engineering Conference and Exhibition [ASME] Boston, MA (ASME)

5-10 SAE West Coast International Meeting [SAE] Portland, OR (SAE)

SEPTEMBER

2-7 International Gas Turbine Symposium and Exposition [Gas Turbine Div., ASME; Chinese Natl. Aero-Technology Import and Export Corp.; Chinese Soc. of Aeronautics and Astronautics] Beijing, People's Rep. China (Intl. Gas Turbine Ctr., 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 - (404) 451-1905)

9-11 19th Midwestern Mechanics Conference [Ohio State Univ.] Columbus, OH (Dept. of Engrg. Mech., Ohio State Univ., 155 W. Woodruff Ave., Columbus, OH 43210 - (614) 422-2731)

10-13 Design Automation Conference [ASME] Cincinnati, OH (ASME)

10-13 Failure Prevention and Reliability Conference [ASME] Cincinnati, OH (ASME)

10-13 Vibrations Conference [ASME] Cincinnati, OH (ASME)

16-20 DIAGNOSTICS - 85 [Technical Univ. Poznan / Polish Academy Sciences] Leszno, Poland (Diagnostics -85, Prof. C. Cempel, Tech. Univ. Poznan, Piotrowo 3, P.O. Box 5, 60-695 Poznan, Poland)

18-20 INTER-NOISE '85 [Intl. Inst. Noise Control Engrg.] Munich, Fed. Rep. Germany (E. Zwicker, Institut f. Elektroakustik, TU Munchen, Arcisstr. 21, 8000 Munchen 2, Fed. Rep. Germany)

22-24 56th Shock and Vibration Symposium [Shock and Vibration Information Ctr., Washington, D.C.] Monterey, CA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Res. Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

OCTOBER

6-8 Diesel and Gas Engine Power Technical Conference [ASME] Grove City, PA (ASME)

8-10 Lubrication Conference [ASLE/-ASME] Atlanta, GA (ASLE/ASME)

8-11 Stapp Car Crash Conference [SAE] Arlington, VA (SAE)

14-17 Aerospace Congress and Exposition [SAE] Los Angeles, CA (SAE)

20-24 Power Generation Conference [ASME] Milwaukee, WI (ASME)

22-24 14th Turbomachinery Symposium [Turbomachinery Labs.] Houston, TX (Dara Childs, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843)

NOVEMBER

4-8 Acoustical Society of America, Fall Meeting [ASA] Nashville, TN (ASA)

11-14 Truck and Bus Meeting and Exposition [SAE] South Bend, IN (SAE)

17-22 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Miami Beach, FL (ASME)

DECEMBER

11-13 Western Design Engineering Show [ASME] Anaheim, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

ASA Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASTM American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

IES Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1, UK

IFToMM International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

SNAME Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375-5000

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